In the name of Allah
the most
Compassionate and Merciful

The Center for the Publication of the U.S. Espionage Den's Documents

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In the name of God, the Compassionate, the Merciful

This book,which includes the second series of oil-related documents, has been published as a means to probe into the unknown,yet very important activities of the Central Intelligence Agency.Documents published so far have revealed the CIA's vile performance in toppling other governments, or its pursuit of other political goals as set by the ruling body in America.

The Agency's past and present records point up the innateness of such operations,leading one to conclude that the CIA's activities could in no way include espionage in the economic arena.

As indicated by the documents seized in the U.S.espionage den,concurrent with the activities carried out by the American departments of energy,commerce,the interior, and the State Department, as well as private institutions like oil companies and major U.S. banks, the Central Intelligence Agency has also employed both overt and covert means to provide the U.S. government with information vital to its policy-making.

The agency's operations in the economic dimension engulf a wide range of issues, but one of them becomes immediately prominent, due to the agency's heavy concentration of efforts in the fields of both energy and oil.This point in fact exemplifies the important role played by oil and energy in the U.S. policy making, while indicating that the oil market is in control of one party that has more information and of course, exerts more influence on the oil-rich countries' decision-makers.

Now, if this were the extent of intelligence gathering, there would have been no problem,perhaps,making the issue appear as the natural need of every government to aid in the adoption of proper decisions.But once it collects enough intelligence regarding even the most insignificant energy issue concerning the Third World states,the agency embarks on exercizing its influence at the various decision-making levels of those countries, ultimately leading to an increase in U.S. capital, further decreasing the vital resources of the energy producing nations, resulting in intense poverty, while the plunderers' agents that are to act as the trustees of the deprived people to whom the oil resources belong, only attend to their own pockets and nothing else.

The energy producing nations' political and economic policies are obviously based on the impact of a scheme worked out for energy exploitation, production, pricing and distribution throughout the world. In other words, the availability of oil for the gigantic industrial machine of the West is a vital issue. All of these conditions indicate that for the western plunderers, the survival or the fall of the puppet regimes is important only as far as oil is concerned, a fact which justifies the CIA'S activities in this respect.

If we decide to categorize all the documents captured in the U.S. espionage den, that also cover the CIA'S spying activities, excluding the ones that analyze oil and energy issues on a world basis, as well as those that contain generalized matters, the following topics would appear, only as far as our own country is concerned:

- To gain a thorough knowledge of oil resources and reserves across the country;
- Discovering oil exploitation techniques for every geographical location and the related requirements;
- Available technical capabilities as far as manpower and equipment are concerned;
- The status of refineries in detail;
- Daily exploitation and production levels at various oil fields;
- Amounts and prices of oil sold daily;
- Technical export capabilities along with an accurate knowledge of loading and export terminals,
- The oil industry's organizational chart and influential elements at all levels;
- Welfare or syndicate status of various classes of workers employed in the oil industry;
- Political inclinations and labor issues in the oil industry and.....

Documents published in connection with other oil-rich states so far, also indicate that the Central Intelligence Agency has had similar espionage operations in those areas.

This book includes a document in which the Agency discusses the world oil market's perspective within a specified seven year period, ultimately intending to estimate the world's demand for OPEC oil as well as how dependent it is on the Organization of Petroleum Exporting Countries. The document takes the period between 1978 and 1985 into perspective, and the procedures involved in the study are as follows:

- Estimating the OPEC'S oil supply until the end of 1985 while studying the production status of the organization's important member countries;
- Establishing various scenarios in the OECD member states' demand for OPEC oil, while determining their energy shortages;
- Estimating demand for oil in the developing countries, the communist states, and the rest of the world;
- A comparison of various supply and demand trends;

Since the conclusions drawn in this sort of a study are basically predictions, one cannot expect a certain degree of accuracy from those trends, while a comparison of documented facts and figures concerning various periods with those predicted in this paper is not practical either, especially because so many unexpected currents and events have changed oil and economic trends, many times reversing their directions altogether.

The Islamic Revolution of Iran was one such event that occurred only six months after the analysis was of the least consideration as to the impacts of this phenomenon on conclusions that had already been drawn.

This revolution greatly affected all political, social and economic trends, while reversing many of the world equations. The CIA economists, according to this paper, intend to coordinate the world's oil-related demand and supply, by establishing scenarios on OPEC's oil production and supply, thus impeding any sudden oil price increases that according to them, would have disruptive impacts on the western economy. In other words, they are trying to trim the growth of prices in proportion to economic growth. It prompts us to think everything over, when we find out that as a result of the shock the Islamic Revolution inflicted on the world's oil market, in less than two years the price of oil reached 38$ from 13$ per barrel, amounting to a 300% increase.

Both this event and measures taken by many major oil consumers to cut their dependence on OPEC oil, coupled with an increase in non-OPEC countries' oil production, caused the world demand for OPEC oil in 1985 to be in the range of 6 to 18 million barrels per day, while this paper had predicted it would be between 32 to 40 million barrels a day.

This introduction cannot include a detailed as well as analytical discussion of these trends. The two examples cited here were only to prevent the reader from making any comparisons between the predicted

facts and figures relating to various time frames and the actual ones, while fully considering the working methods involved, how information is processed and passed on, how much value is attached to different parameters, or the methodology ruling over this analysis.

We apologize to our readers for any errors we might have made in translating the document, due to the volume of work involved, and urge them to direct any comments they might have to the Center for the Publication of U.S. Espionage Den's Documents.

Muslim Students Following the Line of the Imam.
Fall, 1986

NOTE: For figures cited in the text, please refer to the end of the document.

National
Foreign
Assessment
Center

The Oil Market Through 1985

An Intelligence Assessment

Secret
ER 78-10206
August 1978
Copy 350

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The Oil Market Through 1985

Central Intelligence Agency
National Foreign Assessment Center

August 1978

Summary

Scope and Limitations

This study analyzes the prospects for the international oil market during the next seven years.[1] It is designed to identify the circumstances under which demand pressure on available oil supply may push up oil prices and to evaluate how likely these circumstances are to occur, not to work out the ways in which a potential problem may be resolved.

The analysis is complex, because it depends on the interaction of projections of three key variables—economic growth in the industrialized countries, the effectiveness of energy conservation efforts, and oil production. Moreover, projections are inherently uncertain. They depend on historical data, which are subject to various interpretations, and on future events that are unpredictable.

Because of the critical role of the countries associated with the Organization of Petroleum Exporting Countries in supplying world oil needs, the analysis is organized in terms of the demand for OPEC oil and the willingness and ability of the OPEC countries to meet this demand. To simplify the problem, we have limited the analysis in three ways:

- OPEC prices are held constant in real terms.
- We do not consider the impact of possible changes in the energy policies of the industrialized countries.
- We consider only the period through 1985—a period short enough so that leadtimes for planning and implementing major projects are important constraints on the expansion of oil production capacity.

In practice, of course, if energy demand began to put pressure on oil supply, real oil prices would increase and government policies probably would change. Price increases would lower the demand for oil both directly and through their depressing effect on economic growth. Governments probably would take increasingly vigorous steps to conserve energy and to increase supplies.

Within this analytical framework, we have established the following ranges as the probable parameters for the key variables:

- Real economic growth in the countries of the Organization for Economic Cooperation and Development averaging from 3.7 percent to 4.2 percent annually during 1978-85.
- Energy conservation in response to past price increases and existing government policies holding the growth of OECD energy demand to between 70 percent and 80 percent of the rate of economic growth.

[1] This study updates and extends the analysis in ER 77-10240, *The International Energy Situation: Outlook to 1985*, April 1977.

- Oil production in the OPEC countries rising from 31.7 million barrels per day (b/d) in 1977 to between 33 million b/d and 40 million b/d in 1985.

Oil Supply and Demand Through 1985

Our April 1977 study concluded: "In the absence of greatly increased energy conservation, projected world demand for oil will approach productive capacity by the early 1980s and . . . prices will rise sharply to ration available supplies." A number of factors have changed in the past year. Most importantly, evidence is mounting that OPEC, especially Saudi Arabian, productive capacity is not likely to reach the level predicted earlier—in part because OPEC governments, which are assuming an increasing role in key decisions, have different objectives than previous corporate owners. On the demand side, economic growth in the developed countries in 1977-78 seems likely to average about a half a percentage point less a year than anticipated last April, moderating projections of future oil demand. In addition, we have lowered our projections of Communist area maximum net oil imports in 1985, primarily to reflect Soviet and East European hard currency constraints.

Taking all these changes into account, the risk of oil stringencies in the first half of the 1980s—leading to large increases in the real price of OPEC oil—still appears high. Alternative combinations of projections of the three key variables produce a range of several years during which such a problem might first arise.

- If OPEC supplies expand only to 33 million b/d and economic growth rates average 4.2 percent annually, there could be an oil problem as early as 1980.
- Even with OPEC production of 40 million b/d, which we believe to be optimistic, demand for OPEC oil would catch up with supply before 1985 if the rate of economic growth is at the high end of our range.
- A combination of high OPEC supply, low economic growth, and stringent conservation would avoid a problem at least through 1985.

Our judgment about the imminence of a problem is not shared by all oil forecasters. Most projections of energy demand and of domestic energy output in the OECD countries are similar to ours. Few other forecasters have allowed for the possibility that the Communist countries would become net importers of oil, but this difference is not critical to our estimate. If the Communist countries somehow were able to avoid any net oil imports, the projected arrival of demand pressure on oil supplies would be postponed only for about one year. The key difference centers on OPEC supply. The most optimistic forecasters assume OPEC, especially Saudi, productive capacity well in excess of what we consider to be within the range of probable outcomes, although some have lowered their projections in the past year and some of the recent projections are close to our own.

The OPEC Role

We believe that both the willingness and the ability of OPEC countries to supply continually growing oil demand are increasingly doubtful. The expansion of OPEC productive capacity in the next several years is likely to be constrained by the political and economic policies of key producing countries, as well as by technical considerations. Some of the oil-exporting countries, which now control their own resource development, have longer time horizons than the international oil companies. Those with surplus revenue have the options of limiting production to less than existing capacity or holding back on the installation of new capacity. The incentive to restrict oil production may emanate from conservationist concerns about optimizing ultimate oil recovery. Programs to expand productive capacity also may be deliberately delayed or expedited for foreign policy reasons.

Several key OPEC governments already have taken steps that have lowered oil production and limited investments in the expansion of productive capacity. Saudi Arabia and Abu Dhabi have placed production ceilings on specific oilfields and types of crude oil and have imposed operating restrictions on the oil companies.

Saudi Arabia—the Swing Factor

Saudi Arabia, the major producer of increasing amounts of oil for world markets in the last decade, holds the key to OPEC's ability to meet growth in oil demand in the 1980s. The outlook for expansion of Saudi oil productive capacity has worsened considerably during the past year. Aramco, the company responsible for almost all oil production from Saudi Arabia, planned early last year to raise sustainable capacity to 16 million b/d by 1985. That plan was never approved by the Saudis, and it no longer appears to be a feasible goal. The Saudis have placed production ceilings on specific oilfields and on types of crude oil, have imposed operating restrictions on the oil companies, and have limited the funds available to Aramco for investment. In its most recent plans, Aramco has scaled down its expectations to only 11.5 million b/d by 1983.

We believe that sustained production for all of Saudi Arabia of 12.5 million b/d (the figure used in our high projection of OPEC output) could be reached by 1985, given a combination of massive new investments and some relaxation of production restrictions imposed by the Saudis. Reaching this level, however, probably would require pushing some major Saudi oilfields close to their reasonable production limits, as well as timely approval of major investments with lengthy lead-times. By contrast, strict adherence to the rules now in force would push Saudi output below the present maximum allowable production level of 8.8 million b/d (the figure used in our low projection of OPEC output).

From the point of view of narrow economic self-interest, the Saudis may believe they have little to gain from an expensive expansion program that would carry an element of risk. Most senior Saudi oil policymakers strongly favor limiting not only oil output but future capacity. They believe that oil in the ground is the best form of savings and do not want to be in a position of being subjected to outside pressure to produce at higher levels than they consider desirable. Conservationist concerns are bolstered by the opinion of some that miscalculations on safe production levels could lead to a permanent loss of reserves.

Although substantial excess capacity provides leverage over OPEC decisions, the Saudis recognize that large additions to capacity would be eaten up by increased world oil demand. Hence, strong foreign policy considerations probably would have to be invoked to convince the Saudis to make the series of affirmative decisions necessary to reach even 12.5 million b/d sustainable capacity by 1985. On balance, we believe that Saudi production of about 10.5 million b/d (the figure used in our middle projection of OPEC supply in 1985) is a more likely outcome.

Elsewhere in OPEC

As for the rest of OPEC, the chances of substantial increases in oil production are small. With its effort to install huge amounts of new equipment lagging, Iran will see its sustainable capacity decline by the mid-1980s from its current 6.5 million b/d to somewhere between 5 million and 6 million b/d. Iraq should be able to expand crude capacity somewhat, although Baghdad's plans for future output have been scaled down several times since 1973. Conservationist views in Kuwait and Abu Dhabi point against the lifting of their current production ceilings. Nigeria, Venezuela, and Indonesia will do well to maintain current output.

The Communist Countries

Energy production prospects for the Communist countries have not changed significantly since our last paper. We projected a decline in Soviet oil production during 1981-85 to a maximum of 10 million b/d—a level that may meet Soviet domestic requirements but would not leave a surplus for export. Since China will probably continue to export only small amounts of oil and most other Communist countries will run large and growing oil deficits, we still expect the Communist countries as a group to shift from a net oil export to a net oil import position.

How much they will import by 1985, however, is highly uncertain. Their potential demand will depend on economic growth and conservation. Moreover, they will have to allocate their limited hard currency earnings between oil imports and

other high-priority imports. They probably will not be able to afford to buy all the oil they would want if economic growth were the only consideration. The Communist countries as a group were net exporters of 1.1 million b/d of oil in 1977. Taking into account their economic outlook, the prospects for energy conservation and for substitution of other energy sources for oil, and potential hard currency earnings, we believe that the USSR, Eastern Europe, Cuba, and the small Soviet client states in the Far East will import as much as 3 million b/d of oil by 1985 if the real price of oil remains constant. China probably will export about 500,000 b/d, reducing the net import balance for the Communist countries as a group to some 2.5 million b/d.[2]

Although most of these imports would be for Eastern Europe and Cuba, Moscow would have to assist with financing, since the East Europeans and Cubans could not pay for their own oil needs without incurring severe economic problems. Thus, both the USSR and Eastern Europe probably will have to reduce nonoil imports from hard currency countries to pay for oil imports.

Accordingly, it is clear that Moscow faces an oil problem that will be difficult to solve and must make very painful policy choices. These involve tradeoffs between: how much to reduce its nonoil imports from the West to make room for oil imports in its hard currency payments, how much of the burden to assume in order to help Cuba and Eastern Europe, and how much to curtail economic growth in the USSR and Eastern Europe in order to hold down energy consumption and imports.

Other Oil Producers

The growth of available oil supplies outside of OPEC also is expected to slow during the period of this assessment. After approximately tripling in 1978-80 to 2.9 million b/d, North Sea production will likely only rise another 1.4 million b/d by 1985. Output in the United States will likely hold steady in 1980-85; after the first upsurge of Alaskan oil, increments from the North Slope will just about offset declines in production elsewhere. Mexico will be an important source of new oil, with production likely to grow from 1.1 million b/d last year to 3.9 million b/d in 1985, if the expansionist plans of the present government are continued. Most other less developed countries have been searching intensely for oil but their overall net imports still are likely to rise.

Alternative Energy Sources—No Panacea

The development and use of nonoil energy sources are unlikely to offset the slowdown in oil supply growth, although there is considerable uncertainty as to what is achievable for coal and natural gas. This assessment assumes a 25-percent increase of coal production in industrial countries—almost entirely reflecting a 40-percent increase in the United States—between 1977 and 1985. Further increases in coal usage in developed countries will be constrained by (a) high production costs in some countries, (b) inadequate infrastructure, and (c) insufficient incentives to induce industry and public utilities to convert from oil or gas to coal.

Nuclear power probably will more than double its share of OECD energy production in 1978-85, to 11 percent. Additional gains in this time frame are largely precluded by multiyear leadtimes that are being added to by increasing political and legal pressures in many industrial countries. Production of natural gas in the developed countries may decline somewhat, but a sizable rise in

[2] In our April 1977 paper, we projected maximum Soviet oil production in 1985 of 10 million b/d, minimum import requirements for the USSR and Eastern Europe of 3.5 million b/d, and negligible Chinese exports. In the current paper, projected Soviet production is unchanged. The net import figure for the USSR and Eastern Europe has been revised downward to 2.7 million b/d; the 800,000 b/d change reflects our expectations of an additional 700,000 b/d in fuel conservation in the USSR, as well as minor changes in economic growth projections and conservation estimates for Eastern Europe accounting for the remaining 100,000 b/d. Our current projection is that China will be a net exporter of some 500,000 b/d by 1985. Moreover, this paper makes explicit allowance for net imports by Cuba and other Communist countries of 300,000 b/d by 1985 to arrive at a balance of 2.5 million b/d for all Communist countries. A further difference stems from the fact that the April 1977 paper assumed that if Soviet oil production fell short of 10 million b/d, Soviet and East European imports could go as high as 4.5 million b/d. We currently believe that Soviet and East European imports of about 2.7 million b/d are the maximum possible given hard currency constraints and that any reduction of Soviet production below 10 million b/d would not be covered by additional imports but rather would be absorbed by reductions in economic growth in the USSR and Eastern Europe.

imports of natural gas and liquefied natural gas—mostly from OPEC members—should allow some increase in gas consumption by industrial countries. As for other energy sources, the potential of hydroelectric and geothermal power is limited by the availability of resources suitable for exploitation, long leadtimes, and the currently high costs. Existing solar techniques that are cost effective at present prices—construction of buildings to make the best use of sunlight and use of solar energy for hot water heating—probably will continue to be introduced slowly.

Implications for Economic Growth

Most developed countries face a difficult transition to lesser reliance on oil even if conservation efforts lead to a continuing steady decline in the relationship between energy use and GNP in the OECD countries in 1977-85. If energy demand grows about 80 percent as fast as GNP, economic growth rates of even 3.7 percent a year in the OECD would carry a high risk of oil market stringencies before 1985 (see figure 1). This would push up oil prices and subsequently lead to a reduction in economic growth.

Higher conservation would postpone the problem only briefly. Under most combinations of supply and demand, any change that reduced OECD energy demand about 2.5 percent by 1985,[1] and held the growth of energy demand to only 70 percent of the rate of economic growth, would have the effect of postponing market stringencies for a year or so. Conservation even at that rate still results in market stringencies before 1985 unless OPEC production is at the high end of our range.

Political and social pressures in the oil-consuming countries in most cases appear to be at cross-purposes with developments that would reduce potential oil market stringencies by 1985. With unemployment at more than 16 million almost three years after the last recession, OECD governments are under severe pressure to stimulate economic growth. A cluster of national elections scheduled in 1980 and 1981 will reinforce the desire to reflate. While the threshold of public tolerance for unemployment is uncertain, it is doubtful whether many electorates would accept the reality of fewer jobs in the short run to avoid a dimly perceived, oil-induced, economic slowdown a year or more in the future.

Meanwhile, a number of factors impede public, and in some cases governmental, recognition of an impending oil problem. Most importantly there is now a glut on the oil market due to the new flows of North Sea and Alaskan oil at a time of relatively sluggish demand. In addition, the US and European coal industries have substantial excess capacity, in part due to slumping world steel demand. Such conditions will disappear if moderate economic growth continues for the next two years, but they delay the adoption of stronger energy conservation policies as well as changes in lifestyles. In many countries the sluggish pace of investment also postpones the introduction of more energy-efficient production methods and machines.

Plausible Adjustment Paths

The future oil problem may not take the form of a large, rapid run-up in prices such as occurred in 1973 and 1974. If it did, the impact on economic growth, unemployment, and inflation in the industrial countries would again be traumatic. We calculate that an oil price increase of 10 percent now has the same economic impact as a 60-percent increase in 1973, when the weight of oil in economic activity was much smaller. Every 10-percent rise in real crude prices today would cut one-half a percentage point off OECD GNP growth, boost unemployment by some 500,000 persons, and add slightly more than one-half a percentage point to inflation, besides adding to the already severe balance-of-payments problems of many nations.

But the adjustment may be gradual, with a series of moderate price hikes. Oil prices are apt to rise in the next several years in any event, because OPEC countries want to improve their terms of trade which have deteriorated under the impact of world inflation and dollar depreciation. Prices are particularly likely to begin rising as perceptions of a possible supply problem spread.

[1] This is, for example, the approximate impact of energy legislation now pending in Congress, according to Department of Energy estimates.

Figure 1

Scenarios of World Demand for OPEC Oil
(Constant Price of OPEC Oil)

Supply Exceeds Demand
Ex Ante Demand Exceeds Supply

Supply Scenarios	1978	1979	1980	1981	1982	1983	1984	1985
OECD Real GNP Growth 3.7 Percent[1]								
High OPEC Supply								—
Medium OPEC Supply					—	—	—	—
Low OPEC Supply				—	—	—	—	—
OECD Real GNP Growth 4.2 Percent[1]								
High OPEC Supply					—	—	—	—
Medium OPEC Supply					—	—	—	—
Low OPEC Supply			—	—	—	—	—	—

World Demand for OPEC Oil Allowing for Additional Conservation[2]

Supply Exceeds Demand
Ex Ante Demand Exceeds Supply

Supply Scenarios	1978	1979	1980	1981	1982	1983	1984	1985
OECD Real GNP Growth 3.7 Percent[1]								
High OPEC Supply								
Medium OPEC Supply							—	—
Low OPEC Supply				—	—	—	—	—
OECD Real GNP Growth 4.2 Percent[1]								
High OPEC Supply							—	—
Medium OPEC Supply					—	—	—	—
Low OPEC Supply			—	—	—	—	—	—

1. These growth rates were calculated from projections of specific age population trends, projections of participation rates, and the use of historic GNP to employment relationships. They imply constant OECD unemployment assuming the historic relationship between employment and GNP growth (OECD average 4.2 percent) or, alternatively, constant unemployment assuming a decline in the historic relationship of productivity to GNP growth (OECD average 3.7 percent).
2. World energy demand adjusted for a 2.5 percent reduction in OECD energy demand in 1985; amounts rising linearly to this level in 1985. This would be the approximate effect of energy legislation now pending in Congress, according to Department of Energy estimates.

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PREFACE

This study analyzes the prospects for the international oil market during the next seven years. Because the OPEC countries, which produce some 85 percent of the oil moving in world trade, will be the key element in the world oil market during this period, the analysis is organized in terms of the demand for OPEC oil and the willingness and ability of the OPEC countries to meet this demand.

It surveys the likely range of OPEC oil supplies between now and 1985 and contrasts it with several alternative projections of world demand for OPEC oil. It also explores the key factors that will determine various supply and demand outcomes. This study updates and revises the previously cited study published in April 1977 and, like all other attempts to evaluate likely global energy and supply balances, will itself eventually be altered by new information. The analysis in this paper depends heavily on projections, which carry a range of error and need to be revised as additional data points become available.

On the OPEC supply side, we established a range of oil production possibilities in key countries. In common with other market analysts, we attempted to establish an upper level for OPEC production capabilities through 1985 by analyzing governmental plans for development of new capacity, and numerous technical factors including reserve-production ratios and discovery rates. In addition, we identified a number of other—in our judgment more likely—supply outcomes, which depend on resource management policies and a host of institutional and political developments in OPEC countries.

The oil demand scenarios are based on two sets of GNP growth assumptions for the OECD countries* that imply constant unemployment under alternative assumptions about future productivity trends. The scenarios explicitly assume that the real price of oil on the world market will remain constant in the next eight years, that is, increases in the prices of OPEC oil will equal increases in the export prices of non-OPEC countries. They allow for the 2.5-percent annual increase in the real price of energy within the United States that is called for in recent legislation such as the Energy Policy and Conservation Act of 1976. Because we deal with prices and volumes that could occur only if supply remained sufficient, the demand scenarios should be viewed as measuring sticks rather than forecasts. To the extent that a

* Throughout this memorandum, OECD refers to all member countries except Australia and New Zealand, unless otherwise indicated.

particular OPEC oil demand projection outstrips a given OPEC oil supply projection, the stipulated level of demand is not attainable and would be foreclosed by increases in world oil prices. In the absence of offsetting government policies, the increase in prices would bring the demand for OPEC oil in line with supply by lowering economic growth in oil-consuming countries, inducing additional conservation, and increasing non-OECD energy output.

The report, and the analytical process on which it is based, consists of four main parts. First, the likely range of OPEC supplies through 1985 was estimated. Then, various scenarios of OECD demand for OPEC oil were constructed from estimates of OECD energy demand less available OECD energy supplies. Third, the net oil import demand of the non-OPEC less developed countries, the Communist areas, and the rest of the world was estimated. Finally, the various supply and demand scenarios were compared.

Contents

Summary i

Preface vii

I. OPEC Supplies Through 1985 1
Saudi Arabia 3
Iran 10
Iraq 11
Venezuela 11
Nigeria 12
Kuwait 12
Abu Dhabi 12
Indonesia 13
Algeria 13
Libya 13
Others 13

II. OPEC Production Scenarios 15

III. OECD Demand for OPEC Oil 17
OECD Energy Demand in Perspective 18
OECD Energy Demand in the Years Ahead 20
OECD Energy Supplies 24
OECD Net Oil Import Demand 30

IV. Non-Communist Demand for OPEC Oil Outside the OECD 31
Net Oil Import Demand of the Non-OPEC LDCs 31
Other Developed Countries 33

V. Communist Countries in the Oil Market 35
The Soviet Oil Problem 35
Energy-Poor Eastern Europe 39
Other Communist Countries 39
Continuing Chinese Exports 40
Communist Oil Trade Balances 40

VI. World Demand for OPEC Oil Through 1985 43
Oil Supply and Demand Balances: Implications 43
Counterpressures 45
Impact of a Possible Price Rise 46
OPEC Pricing Decisions 46
Concluding Note 48

Appendixes

A. Methodology 49
B. Supplemental Statistical Tables 59
C. *The Oil Market Through 1985* Compared With *The International Energy Situation: Outlook to 1985* 71
D. World Demand for OPEC Oil 73
E. Energy Supply and Consumption in the USSR 77

The Oil Market Through 1985

I. OPEC SUPPLIES THROUGH 1985

Technical, economic, institutional, and political factors are likely to limit the availability of OPEC oil in the next eight years. Estimates of future production must take into account not only considerations such as the resource base and the infrastructure to produce and deliver oil but also increasingly the perceptions of governments in producer nations as to how these resources should be exploited.

Until recently, production programs in OPEC countries were based largely on oil company criteria for satisfying market demand. With nationalization, these criteria are in the process of changing. The time horizons of most governments are significantly longer than those of the companies (which means that the pertinent discount rate is significantly lower). The relative values placed on future as against present production differ; so do perceptions of the merits of current investments and operating practices in enhancing long-run oil recovery.

Several key OPEC governments already have taken steps that have lowered current oil production and limited investment in the expansion of productive capacity. Saudi Arabia and Abu Dhabi have placed production ceilings on specific fields and crude types and have adopted other operating restrictions that keep output below capacity. These policies have been adopted at a time when the oil market is weak and could be relaxed or removed as supply stringencies appear. They may persist, however, and restrict the operating environment of the oil companies in the future.

More important, the expectation that governments intend to hold production below existing capacity can create a disincentive to invest not only in new capacity but even in maintenance of existing capacity. Kuwait offers one clear example. Because of its large surplus revenues and strong conservationist sentiments, it maintains an annual production ceiling about 1 million b/d less than current sustainable capacity. As a result the Kuwaitis and the contractors operating the fields have had no reason to engage in new drilling and to do routine maintenance work, such as well workovers, in excess of their needs, and productive capacity has declined about 500,000 b/d since 1973. Similarly a Saudi decision to curtail output from Ghawar—the world's largest oilfield—has been reflected in cancellation of orders for desalting equipment. In the absence of these desalters, the number of wells in Ghawar that are shut in because of water encroachment will continue to increase and capacity will decline further.

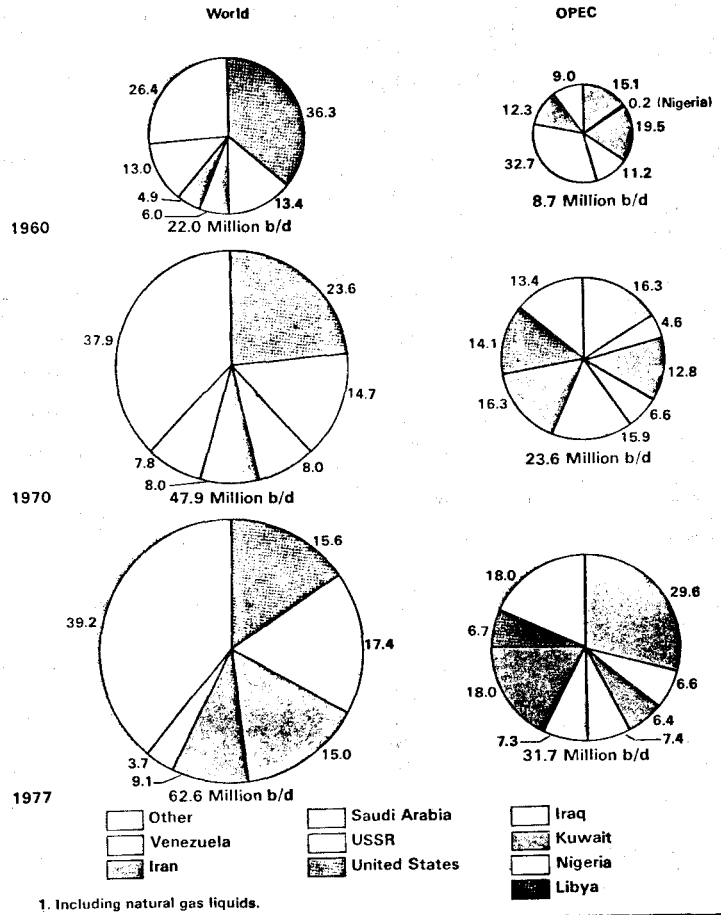
In establishing a range of likely OPEC oil supplies through 1985, we considered three concepts of OPEC productive capacity.

- **Installed capacity**, also called "facility capacity," is the maximum capacity of the oil wells, the pipelines, and the rest of the delivery system. It does not take into account normal operational constraints such as downtime for maintenance and weather.
- **Sustainable capacity** is the rate at which production could be sustained for an extended period—several months or more—without damage to the oilfield. For each field, this capacity concept contains an element of judgment. Well-qualified petroleum engineers could and do disagree—often widely—on the maximum rate at which a given field could safely be produced.
- **Allowable capacity** is the rate of production that is permitted by government regulations.

Figure 2

Oil Production Market Shares[1]

Percent



1. Including natural gas liquids.

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Our OPEC production projections take all three concepts of capacity into account. We consider existing plans in each country for installed capacity based on capital investment, the time required to develop proved and probable reserves, and government policy. Sustainable capacity is projected based on historical production experience and engineering studies where available, quite often it runs at some 90 to 95 percent of installed capacity. In each case where government ceilings on allowable production are in effect—such as in Saudi Arabia, Kuwait, and Abu Dhabi—we project a range of output possibilities that reflects policy options of the government concerned.

Saudi Arabia

Saudi Arabia holds the key to satisfying growing world oil demand in the 1980s. Saudi Arabia's proved and probable reserves total about 150 billion barrels—almost a fourth of the non-Communist world's known oil reserves. For more than a decade, it has been the largest single source for supplying the world's increasing energy requirements. By 1977 the Saudis accounted for 29.6 percent of OPEC output, compared with only 15.1 percent in 1960. Between 1970 and 1977, they accounted for 40 percent of the increase in world oil production, boosting their share of world output to 15 percent (see figure 2). Output remains very low in relation to reserves.

The outlook for continued rapid expansion of oil production capacity in Saudi Arabia has, however, worsened considerably during the past year. An earlier Aramco plan to increase sustainable capacity in Aramco-controlled areas to 16 million b/d by 1985 has been set aside. An investment program to boost sustainable capacity to 12.4 million b/d by 1983 and 12.7 million b/d by 1987 was approved in principle by the Saudis in late 1977, but Aramco believes that investment conditions imposed by the Saudis rule out attainment of the proposed level. Under the investment guidelines currently in force, Aramco tentatively projects sustainable capacity of 11.5 million b/d by 1983 [1] (see table 1).

[1] These plans exclude capacity in the non-Aramco concessions in the Neutral Zone, which Saudi Arabia shares with Kuwait. Figures for present total Saudi capacity include 300,000 b/d of capacity in the Neutral Zone.

Table 1

Aramco Plans To Expand Sustainable Oil Productive Capacity [1]

Million b/d

Target Date (Yearend)	Date of Plan			
	April 1977	Late 1977	March 1978	May 1978
1978	11.7	10.9	10.4	10.5
1979	12.2	11.2	10.6	10.7
1980	12.9	11.2	10.6	10.7
1981	14.0	11.7	11.0	11.2
1982	15.2	12.3	11.4	11.5
1983	15.7	12.4	11.4	11.5
1984	15.7	12.7	NA	NA
1985	16.0	12.7	NA	NA
1986	16.0	12.7	NA	NA
1987	16.0	12.7	NA	NA

[1] Installed capacity in Aramco areas is approximately 1.5 million b/d above these levels. Figures exclude capacity attributable to the Neutral Zone.

Investment plans reflect financial considerations as well as technical problems in some oilfields. Both factors are reinforcing tendencies by the Saudi Government toward conservationist policies on oil resource development. These attitudes have led to restrictions on oil production and to cuts in investments. A decision to raise capacity substantially, therefore, is unlikely to be made except for compelling foreign policy reasons.

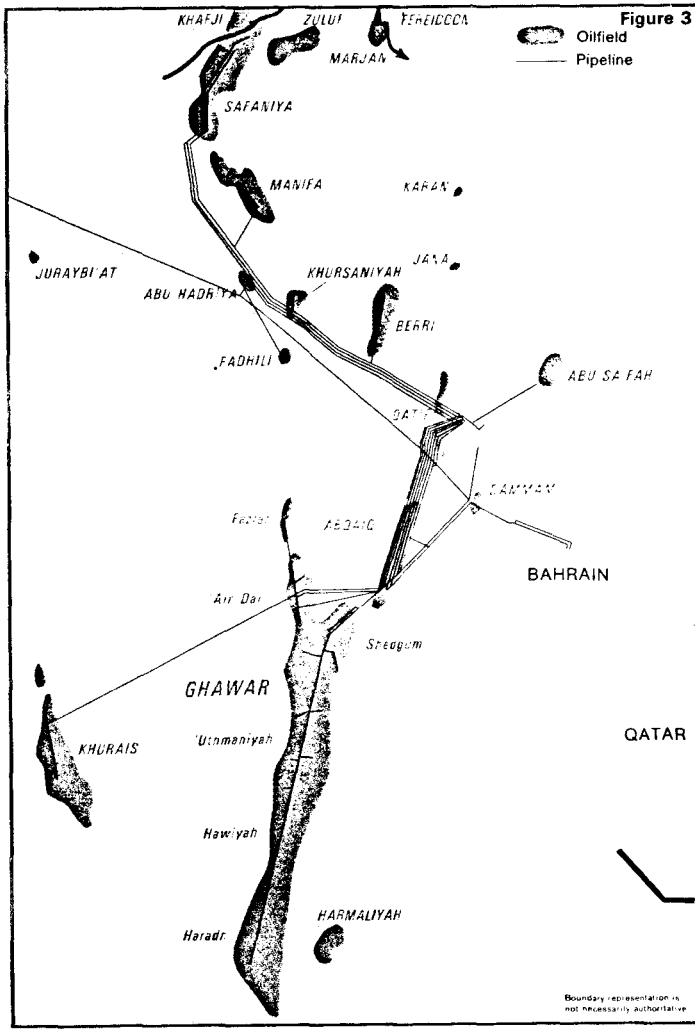
Given a number of factors discussed in detail below—Saudi conservationism, the costs and time to solve technical problems, and recent Saudi investment decisions—no more than 1 or 2 million b/d is likely to be added to current sustainable capacity in Saudi Arabia of 10.4 million b/d by 1985. Indeed, capacity could remain stable or even decline, depending on Saudi decisions.

Technical Considerations

A number of technical problems have emerged in Saudi Arabia that are typical of the maturing process in oilfield development but comparatively new to the Saudis.

- As an oilfield is produced, natural pressure drops, at some point, adequate volumes of water or gas must be artificially injected into the reservoir to maintain production rates

Saudi Arabia: Selected Oilfields



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and prevent permanent loss of some portion of recoverable reserves.

- When oil wells begin to produce traces of saltwater that is seeping into oil reservoirs, desalting equipment must be installed to separate saltwater from oil or the well must be shut down.

Technical considerations are only a subordinate aspect of the overall decision the Saudis must make on future oil capacity and production policy. Nonetheless, technical problems play an important part in determining how long it will take and how much it will cost to reach any given capacity level. Moreover, until decisions are made on how to handle technical problems, sustainable capacity is likely to decline.

The appearance of technical problems at Ghawar—the mammoth Saudi field that accounts for 9 percent of total world crude output—and other major Saudi fields, which also are extremely large by world standards, presents difficulties of unique scale and complexity (see figure 3). The potential loss of reserves that could stem from miscalculations is enormous. Consequently, the normal uncertainties in predicting oilfield behavior have led to a wide range of judgments as to what production rates are feasible and prudent. Moreover, the assessments of the experts depend in part on whether they are estimating what the system can produce if pushed or what it should produce with minimum risk.

Reflecting Saudi desire to maximize the ultimate recovery of oil resources, the Petroleum Ministry has reacted to such uncertainties by imposing restrictive operating rules on Aramco. A production ceiling on Aramco of 8.5 million b/d, imposed as a conservation measure before the 1973 Arab oil embargo but lifted in 1977 when Saudi Arabia temporarily split with other OPEC countries on the issue of oil prices, was reimposed at the beginning of 1978, and the Saudis are discussing reducing the ceiling further. Even if the ceiling is not lowered, other rules described below that have been imposed or are under consideration by the Saudis could hold Saudi output to less than 8 million b/d for two years or more.

Saudi Arabia notified Aramco in February that production of Arab Light crude must average no more than 65 percent of oil output. Within the 8.5 million b/d production ceiling, the 65-percent rule allows Aramco 5 million b/d of Arab Light crude and Petromin another 500,000 b/d. Sustainable capacity in Berri Extra Light crude and in medium and heavy crudes is about 3 million b/d—barely sufficient to allow total Aramco production of 8.5 million b/d.

Petroleum Ministry technicians are discussing the possibility of reducing the allowable Arab Light crude ratio further—to 60 percent or less by 1979 or 1980—in an effort to bring production of various crudes closer in line with oil reserve ratios. Such a step would allow production of no more than 5.1 million b/d of Arab Light within the 8.5-million b/d ceiling. Unless the Saudis expand capacity in Berri Extra Light and medium and heavy crudes beyond the 3 million b/d, however, the effect would be to limit output to no more than 8.1 million b/d. In any event, the overall ceiling is to be replaced by ceilings for each field that are likely to be even more restrictive, at least initially.

Ratio restrictions are a useful device for guiding the production mix during a period of slack markets while maintaining flexibility to deal with increases in demand when they occur. From a policy point of view, the Saudis want to encourage sales of medium and heavy crudes while saving as much light crude as possible for the future. They can limit their output now without creating problems for the consuming countries because other OPEC countries have enough underutilized productive capacity to prevent market shortages. As the market tightens in the early 1980s, the Saudis will have the option of relaxing ratio rules to moderate price increases and forestall supply shortages.

Even before the 65-percent rule was imposed, Aramco was instructed to avoid production in any area where reservoir pressures have fallen below the "bubble point"—the pressure level at which dissolved gas in an oil reservoir begins to separate from oil. Sharply increased growth in Saudi oil output in the early 1970s was not

accompanied by enough water injection to maintain pressures; reservoir pressures, particularly at Ghawar, fell substantially below the bubble point. The volume of water injection has significantly increased since 1974, leading to partial pressure restoration; but large areas of Ghawar containing some of the most prolific oil wells are still below the bubble point.

Experts differ on how far pressure in any particular reservoir can be allowed to remain below the bubble point. As pressure continues to fall, it eventually reaches a level known as "critical gas saturation." At this point, the gas which already has separated from the oil begins migrating away from its original location. Water injection can restore pressure but usually cannot force the gas back into the oil from which it came. The absence of gas leads to a permanent loss in the volume of recoverable oil.

The Petroleum Ministry has been advised by Aramco that the proportion of migrating gas in Ghawar is greater today than a couple of years ago, despite repressuring. Under these circumstances, the Ministry favors a conservative production course to minimize the risk of losing future production. Aramco pressure maps indicate that strict enforcement of the bubble-point rule could cut Ghawar oil output to less than 3.5 million b/d in 1978—about 2 million b/d below its 1977 output—and limit total Saudi output to as little as 7 million b/d.

Changing Investment Plans

Operating restrictions could be relaxed as demand for Saudi oil rises, but the Saudis also are holding back on investment. Deferral of maintenance work and some equipment orders in recent months has already resulted in lost time. Each new delay in investment inevitably postpones the availability of new capacity, because leadtimes are often inflexible. Thus, even a reversal of Saudi policy in the near future would not fully offset the impact of recent policies on capacity in the early 1980s.

A year ago Aramco had plans to raise maximum sustainable capacity to 16 million b/d by the mid-1980s, but these had not been approved by the Saudi Government. Those plans have now been scaled back substantially. The company now tentatively expects to be able to increase its installed (facility) capacity from 12.5 million b/d in 1978 to only 13.1 million b/d in 1983 and its maximum sustainable capacity from 10.1 million b/d to 11.5 million b/d in the same period.[2]

After almost a year of uncertainty, the Saudi Government apparently has approved the latest investment package, including financing levels and individual major projects. The Aramco shareholders doubt the Saudis will be willing to permit any upward revision of the plan for 1983 or any substantial expansion of capacity during 1984 and 1985. They feel, therefore, that the effect of approval of the plan to reach 11.5 million b/d in the Aramco areas by 1983 is to limit sustainable capacity for the country as a whole to about 12 million b/d by 1985.

From Aramco's point of view, investment capital is the limiting factor. The company was instructed last November to assume for revenue planning purposes that Aramco oil production remains constant at 8.5 million b/d through the 1980s. At the current allowance for reinvestment of about 50 cents of Saudi revenue per barrel produced, the derived annual revenue amounts to about $1.6 billion.[3] That ceiling could, of course, be raised. But Saudi approval of the Aramco plan based on the investment ceiling makes such a reversal of policy unlikely, at least in the near term. While the ceiling holds, the large funding requirements of projects needed to sustain existing capacity leave little capital available for expansion.

Maintaining Capacity

A key consideration is the cost of water-injection projects. Under current practices, maintaining capacity while complying with the rules on pressure maintenance in the oil reservoirs will necessitate expanded volumes of water injection. However, there are as yet no plans for net

[2] These plans exclude development of capacity in the non-Aramco concessions in the Neutral Zone which Saudi Arabia shares with Kuwait.

[3] The large multibillion-dollar gas utilization and electrification schemes Aramco was tasked with managing are separately funded.

additions to supplies of water for injection. All planned projects are designed to substitute seawater for subsurface water.

Heretofore, water has been drawn from aquifers (water-bearing substrata), but concern over the drain on subsurface water resources has led the Saudis to insist on substituting treated seawater as the primary source for injection. The first increment of seawater will be available this year when the seawater facilities in the North Uthmaniyah section of Ghawar—handling about 4.3 million b/d of water—are operational. For this section of Ghawar, about 1.7 barrels of water must be injected for each barrel of oil removed; hence the system about to come on line is necessary to restore sustainable capacity of North Uthmaniyah from about 1.8 million b/d to 2.6 million b/d. The full capacity will not be available, however, until the desalters discussed below are installed.

In early 1978 the Saudi Petroleum Ministry directed Aramco to build a second project to supply an increment of 4.3 million b/d of seawater for the Ain Dar/Shedgum areas of Ghawar. This project, with a target completion date of June 1982, entails looping the existing seawater pipeline and adding pumps and water treatment facilities; it will cost $1 billion that Aramco otherwise could have used to add about 1 million b/d in new oil capacity. As planned, the project would support production of 2.6 million b/d from the Ain Dar/Shedgum areas. It may be cut back, however, since the Petroleum Ministry apparently plans to restrict oil output somewhat. In any event, the seawater project is intended to replace aquifer water and clearly will not lead to increases in capacity.

The need to fund massive new water-injection facilities within the Saudi-imposed investment limit has led to major delays in a desalting program. The late 1977 Aramco plan originally called for placing almost $1 billion worth of desalting equipment at most of the gas-oil separating plants on Ghawar and Abqaiq prior to 1981. However, procurement of all but three of the 25 planned desalting units has been deferred until after 1981. This equipment was intended to handle more than 6 million b/d fluid (oil and water combined). The three desalters now on order are insufficient to maintain Ghawar's present rated sustainable capacity. More than 200 oil wells are already shut in because of saltwater encroachment; until the additional units are received, more wells will have to be shut in each year as they encounter corrosive saltwater.

Expansion Possibilities

Aramco's present plan assumes that the funds remaining after allowing for the projects necessary to maintain current capacity will be sufficient for adding new capacity of only about 1 million b/d by 1983. Most of the additions would be in offshore fields—especially Marjan and Zuluf—and would require primarily new drilling and pipeline collection systems.

Assuming that Aramco reached 11.5 million b/d by 1983 or so, sustainable capacity probably could be raised to 12.5 million b/d for Saudi Arabia as a whole by 1985. The Saudi share of capacity in the Neutral Zone probably will rise to about 500,000 b/d in the interim. Several options are available that could be pursued singly or in combination to add another 500,000 b/d. For example:

- Shaybah, which contains half the proved reserves in the 22 known Saudi fields that have not yet been brought into operation, is already partly developed. Aramco has ceased work on it because of investment constraints but believes that about 500,000 b/d could be put on line from Shaybah by 1985.
- Manifa, an oilfield that produced 45,000 b/d in 1977, was expected to produce 475,000 b/d under the April 1977 Aramco plan. Because Manifa has a heavy crude containing metallic impurities that make it only marginally economic from a refining standpoint, its expansion was one of the first projects canceled by Aramco when plans were scaled back, but the project presumably could be resurrected.
- Alternatively, installation of further desalters probably would be sufficient to allow reopening enough wells in the Aramco areas to

reach 12.5 million b/d for the country as a whole.

To raise sustainable capacity beyond 12.5 million b/d by the mid-1980s would require a major shift in project priorities and substantial new commitments to investment. The investment constraint is a matter of policy and, hence, reversible. Ghawar has considerable potential for increased output in the longer term. But some types of programs probably could not be finished by 1985.

The most significant technical limit on the timing of new production capacity involves additional water-injection capacity. To adequately maintain reservoir pressures at rates of oil production beyond 12.5 million b/d would require the introduction of significantly larger volumes of water than are provided for under current plans outlined above. But a comprehensive seawater-injection program beyond the two projects now authorized cannot be designed until the performance of the first project for North Uthmaniyah has been thoroughly evaluated. Allowing one year for evaluation and one for design pushes the earliest date for project approval to 1980. Approximately five years would be required for manufacture and installation of key items of the necessary equipment, assuming that potential suppliers have the necessary manufacturing capacity. Thus completion of the necessary water-injection program by sometime in 1985 is feasible. But Bechtel, the prime contractor for the two existing seawater-injection projects, believes that such timing would be incompatible with good project management. Even assuming an early decision by the Saudis to press forward with expansion, it seems much more likely that management considerations, competition from other equipment purchasers, and the normal program slippages often encountered in major engineering projects would delay completion until 1986 or 1987.

Oil production capacity could be increased without added water-injection capacity if the Saudis were willing to permit the injection of water inside the oilfields rather than only on their periphery. The company is urging the Saudis to relax this position. Doing so would permit Aramco to restore pressures more rapidly and increase the payoff from the any given volume of water. This practice, combined with the widespread installation of desalters, would be the most efficient approach to substantially increasing capacity in Saudi Arabia.

Saudi officials, however, are concerned that water injection within Ghawar could lead to an unacceptably large loss of recoverable reserves and thus far have resisted all advice to the contrary. Because of Ghawar's enormous size, the distance from the periphery of the field inhibits the restoration of pressure near the center by peripheral injection alone. Assuming that injection inside Ghawar was carefully designed, the actual loss in recoverable oil could be minor. There is a risk, however, that unforeseen reservoir characteristics could lead to serious damage. In some cases, including two major reservoirs in Abu Dhabi, injection into highly permeable strata has resulted in substantial oil being bypassed. Since even a small proportional loss in ultimate recovery at Ghawar would represent a very large volume of crude, the Saudis are reluctant to take any risk they judge unnecessary.

Sustainable oil capacity also could be increased relatively rapidly, and at moderate cost, if the Saudis were willing to relax their restrictions on use of aquifer water. Once seawater injection is under way at Ain Dar/Shedgum and at North Uthmaniyah, facilities for supplementary injection of aquifer water probably could be added within two years or so. From a policy point of view, the Saudis want to reserve aquifer water for future agricultural use. That consideration, however, is only one of many that will weigh in ultimate decisions.

The Saudi Perspective

The question with which the Saudi hierarchy has been wrestling is what to do now about future capacity. The arguments against large increases in the near future are relatively straightforward:

- The Saudis do not need increased income. At current OPEC prices, the revenues Saudi Arabia can expect to derive from continued production at current levels and from invest-

ments abroad are ample to fund development plans and foreseeable foreign-policy needs.

- The inflation Saudi Arabia has experienced in the last four years resulted from the rapid increase in expenditures from oil revenues. With inflation now largely under control, the Saudis fear rekindling it.
- If foreign demand does not rise enough in the next several years to justify the added capacity, investment in added capacity would be a waste of funds.
- If capacity is available and demand does rise, the Saudis will be under pressure to increase production and allow their reserves to be depleted.
- Expectations of substantial increases in the value of oil over the long run make oil in the ground a very attractive form of savings.

Arguments in favor of increasing capacity are somewhat more complex, involving calculations of world economic and political stability. The Saudis have a substantial stake in the future of the Western world, and they know it. They have large financial interests that would be severely damaged by economic disruption in the United States and Europe. They are also concerned that economic dislocations in the United States and Europe could open the way to Communist domination of some Western governments. From a geopolitical viewpoint, therefore, they are anxious to cooperate in maintaining world economic well-being and political stability. Moreover, if they believe that increased Saudi production will be essential to preservation of the world order, the best protection for their existing oil reserves might be installation of additional capacity designed to minimize technical risks. Substantial excess capacity also is useful for leverage in OPEC.

A major factor in the Saudis' thinking is the link between the decisions on capacity and OECD trends in consumption. The Saudis want to encourge OECD conservation in order to reduce the demand for more and more oil. They can directly induce conservation by raising OPEC prices as market circumstances permit, although they want to avoid increases that would fuel inflation in the OECD countries. They can attempt to "jawbone" the OECD into more vigorous conservation. And they can seek to make additions to their own productive capacity contingent on OECD conservation actions.

Saudi decisionmakers also must consider domestic political reaction to their policy on productive capacity. The idea that Saudi resources should be husbanded for the benefit of future generations is widespread. Many in Saudi Arabia are coming to believe that the country gives more than it gets in the relationship with the West in general and the United States in particular. No production price policy could be sold politically in Saudi Arabia, therefore, if it appeared to be a blatant sacrifice of Saudi interests to those of the West.

Several members of the Supreme (Higher) Petroleum Council strongly favor limiting Saudi oil production and future capacity because they believe oil in the ground is the best form of savings. The current glut on the world oil market has given them time to consider their options carefully. Moreover, the period of indecision over future capacity levels has been extended by the normal sluggishness of the Saudi decisionmaking process, which is based on compromise, conciliation, and the fine art of postponement. Where uncertainty or opposition to change exists, procrastination is the rule. On key issues where consensus for change is lacking, inertia prevails unless other considerations are overriding.

A struggle within the Saudi hierarchy for control of oil production and investment policy—which now seems to have been partially resolved—has reinforced the tendency to postpone decisions on expansion plans. Oil Minister Yamani favored establishment of an autonomous governmental enterprise, headed by one of his proteges, to determine Saudi petroleum investment requirements independently of the Supreme Petroleum Council. He was opposed both by Finance Minister Aba al-Khayl and by Planning Minister Nazir, who were each anxious for their own reasons to keep major decisions in the Supreme Petroleum Council, of which they are

members. At issue was financial control and a general contest for power and influence.

Crown Prince Fahd has decided to place the new national oil company that will be established upon implementation of the pending Aramco nationalization under the direction of the Supreme Petroleum Council. In any event, the struggle has been over decisionmaking power, not over future production levels. Most of the Saudi leaders on both sides of the struggle, including Yamani, would prefer to limit future Saudi oil production to 12 million b/d or less.

For long-term policy planning purposes, the Saudi leaders appear to be coalescing around a national oil production profile that plateaus at 12 million b/d in the mid-1980s. On the basis of current Saudi reserves and expectations of future discovery rates, this rate could be sustained for 25 to 30 years before production began declining slowly over several decades. The Saudis judge a higher plateau—for example, 14 million b/d—much less desirable because that level could be sustained for only about 15 to 20 years, and the subsequent decline would be more rapid. Even higher levels are feasible purely from the standpoint of normal production-to-reserve ratios elsewhere in the world, but they are even less desirable in the Saudi view.

Outlook

On balance, we believe it highly unlikely that Saudi Arabia will attain more than about 12.5 million b/d of sustainable oil production by 1985. Adding even the 2 million b/d needed to raise sustainable capacity to 12.5 million b/d is a massive undertaking. Saudi policy is to optimize ultimate oil recovery, not to increase income in the near term. It would appear that even the decision to raise capacity from the current level of 10.1 million b/d to 11.5 million in the Aramco area by 1983 is one the Saudis have been reluctant to make. If they go further, it likely will be for strong foreign policy reasons.

As they move to expand sustainable capacity, Saudi Arabia probably will opt to shape major new investments in ways consistent with ensuring maximum long-term recovery. This would likely mean continuing operating constraints, including production limitations, to avert possible damage to the fields. This strategy would have considerable political support. Such an approach would also leave the Saudis with some flexibility to respond to urgent entreaties for increased output by relaxing operating constraints as a last resort.

Iran

Iran's sustainable capacity now stands at about 6.5 million b/d. The critical factor in determining future Iranian capacity is the timing and degree of success in implementing a massive gas-reinjection program and other large-scale investments in the leading oilfields operated by OSCO—the consortium of foreign oil companies that produces most of Iran's oil.

Pressure maintenance at Marun and Ahwaz—the two largest consortium fields, accounting for more than 2 million b/d of oil production (and most of the natural gas exported to the USSR)—is of serious concern to the National Iranian Oil Company (NIOC). The secondary gas cap on Marun is expanding rapidly, and NIOC has ordered OSCO to cut back gas production at Marun and Ahwaz by 1981. Meanwhile, natural gas from the Pars Field is to be brought up to Marun for injection beginning in 1981. Gachsaran, the third largest oilfield, is already under gas injection, and a gas-injection pilot program is under study at Karanj. Agha Jari, the most extensively produced oilfield in Iran, is now in a state of decline.

OSCO projects that its sustainable capacity will rise slightly by 1980, to 6.2 million b/d, and then decline—to less than 5.8 million b/d in 1985. Maintaining even 5.8 million b/d, however, is contingent on achieving a complex schedule of investments in maintenance and secondary recovery. A costly gas-injection program ($11 billion during 1978-84) is intended to enhance total recovery substantially by extending the life of the fields, *not* to lead to higher peak production. In addition, about $500 million annually is required for investment in desalters, well workovers, and drilling. And new discoveries would have to average 500 million barrels per year to support planned capacity levels. The gas-injection program is seriously lagging, however. Moreover, the decline in OSCO capacity may already have

begun. Recent OSCO field assessments indicate that sustainable capacity in April 1978 was less than 5.9 million b/d, compared with 6.1 million b/d at the end of 1977 and 6.3 million b/d at the end of 1976. The likelihood of successful exploration drilling programs seems low, given the disappointing results of the recent past. All things considered, we believe that OSCO is unlikely to achieve its targets.

Iran's four joint ventures outside areas operated by OSCO produced some 600,000 b/d in 1977, and their output should increase moderately by the mid-1980s. Reserves in these joint-venture fields are low by Middle East standards, and prospects for substantial additional discoveries are slim. Most of the fields were discovered in the early to mid-1960s, and the area has been intensively explored. The increase in joint-venture output will not nearly offset the projected decline in the OSCO fields. Under the most optimistic assumptions, joint-venture production could reach 1 million b/d by 1985; a more likely outcome is 700,000 b/d.

We believe that the combination of falling capacity in the OSCO fields and only moderate increases in the joint-venture fields will result in sustainable capacity in Iran in 1985 of between 5 million and 6 million b/d, compared with the 6.5 million b/d today.

Iraq

The Iraqi Government plans to expand sustainable capacity of crude from 3 million b/d in 1978 to 4 million b/d by the mid-1980s. Few details on this planned expansion are available. Development of Iraq's oil production has been slower than anticipated, and Baghdad's plans for future output have been scaled down several times since 1973. The leading oilfields—Kirkuk and Rumaila—have approached their peak production potentials and will require large-scale remedial work to sustain output. Increases will have to come from more recent discoveries.

Braspetro—the foreign subsidiary of the Brazilian state oil monopoly—and Elf-Erap of France, which are both operating under service contracts with Baghdad, have announced oil discoveries adding more than 3 billion barrels of recoverable reserves since 1974. Further exploratory drilling is planned by these firms. Assuming that production at older fields will remain steady through the period, planned development of these new fields could permit an expansion of total Iraqi crude oil production to 3.5 million to 4 million b/d by 1985.

Venezuela

At 2.2 million b/d in 1977, oil output was almost 400,000 b/d below sustainable capacity but equal to planned conservation levels. However, Venezuela needs to step up its exploration efforts to locate more reserves offshore in the Caribbean and in Lake Maracaibo just to be able to maintain its capacity. Since nationalization, these efforts have been disappointing. Exploration activity in 1976 remained near the low levels of company drilling in the last year of private ownership, and drilling outlays in 1977 reflected only moderately greater activity. At present development rates, we expect capacity to decline somewhat—from 2.6 million b/d at present to about 2.4 million b/d by 1980 and some 2.3 million b/d by 1985.

The government plans to give greater emphasis to accelerating exploration and maintaining production capacity in 1978-80. It will concentrate on the promising, but difficult, offshore areas and development of the Orinoco Tar Belt. Venezuela hopes to find 6 billion barrels of oil during the 1976-80 period, which would yield a net increase in proved reserves of about 2 billion barrels by 1980 if production continues at current levels in the interim.

Finding and developing new reserves will require increased participation by foreign oil firms. Without such help Venezuela will be unable to develop independently the sophisticated technology necessary to exploit offshore areas and the Orinoco. In the longer run, substantially increasing recoverable reserves will depend on success in being able to exploit the Orinoco Tar Belt, which is estimated to contain up to 700 billion barrels of oil. Only a small fraction of this is recoverable at current prices.

Nigeria

Oil reserves in Nigeria have declined since 1975 as a result of reduced rates of exploration and discovery. If present trends continue, it will be difficult for Nigeria to produce efficiently at former high output rates—that is, 2 million to 2.3 million b/d attained in the early and mid-1970s. Nigerian fields are small with short productive lives. As a result, an active exploration program is required just to maintain productive capacity, and capacity could decline slightly from its current level of 2.3 million b/d until the benefits of new development begin to come onstream.

Unlike many other producing countries, however, Nigeria is taking positive steps to increase exploration. Oil company response to a new investment incentives program introduced late last year has been generally favorable. A resultant increase in exploration and development activity could provide sufficient additional oil reserves to enable output to remain near current levels into the early 1980s and perhaps increase slightly by 1985.

Even with the new incentives, operating companies still foresee problems for Nigeria in the mid-1980s. While the terms are generally viewed as adequate to stimulate exploration onshore and offshore in water less than 90 meters deep, they are not considered sufficient incentives for increased exploration in deeper, more expensive offshore areas. More activity will be needed in these areas shortly if Nigeria is to support current output levels past the early 1980s.

Kuwait

Kuwait has been producing only about 2 million b/d for the last three years although it has sustainable productive capacity of 3.3 million b/d (including the Neutral Zone). The Kuwaiti Government has set a production ceiling of 2 million b/d on the Kuwait Oil Company, which produces most of Kuwait's crude. Conservationist segments within the government argue that production should be reduced to 1.5 million b/d to protect the national patrimony for future generations. This level is often cited as the volume of oil output necessary to provide sufficient associated natural gas for Kuwait's domestic requirements.

Productive capacity could be greatly expanded if large investments were made. One recent OPEC study held that Kuwait's output could rise to 4.28 million b/d in 1985 and to about 6.5 million b/d sometime after 1990; this would require a multibillion-dollar investment program. The principal constraints to raising productive capacity are (a) the lack of surface installations for separating water produced with the oil and (b) the limited fresh water supply for crude oil processing. Given Kuwait's large and continuing surplus revenue position and the policy of stretching out production as long as possible, government officials are unlikely to allow annual average production much above 2 million b/d in the near term let alone undertake a major new investment program.

Abu Dhabi

Abu Dhabi has imposed operating restrictions on foreign oil companies that will limit 1978 production to 1.5 million b/d—about 400,000 b/d below sustainable productive capacity. The government has made it clear that conservation will play an important role in future Abu Dhabi supply decisions. Abu Dhabi Oil Minister Utayba announced in late 1977 that allowable production ceilings have been reduced for some oilfields because the government fears that the fields were being produced too rapidly. He further indicated that future production might be constrained by the absence of new additions to reserves.

Capital expenditures for exploration and production from 1978 to 1984 are projected at approximately $4.5 billion. About 40 percent of this investment will go to develop the upper structure of the offshore Zakum Oilfield which is believed to have a production potential of 500,000 b/d to 1.3 million b/d; another 12 percent will be invested in unproduced structures in two other offshore fields with a combined potential of about 200,000 b/d. Only a portion of these oil supply additions could be available by 1985.

Indonesia

Indonesian oil production reached a record 1.7 million b/d in 1977 and probably will not increase much by 1985. Exploration has practically ceased as a result of worsening relations between industry and government and successive revisions of existing foreign operators contracts. Few new fields are expected to be found without a vigorous offshore exploration effort. Indonesia's offshore oil deposits have a short economic life and substantial investment in exploration and development is required to offset this rapid depletion. Oil companies operating in Indonesia have requested more favorable tax treatment to rejuvenate exploratory drilling, without which production is likely to decline before 1980.

The country's potential for new reserves is limited by its geological structure, which typically yields small reservoirs with rapid depletion rates. The Minas Field in Central Sumatra, which produces about 360,000 b/d, is Indonesia's only truly large oilfield. There is no expectation that another field as large as Minas will be found. Future discoveries are likely to be limited to smaller reservoirs which require relatively high capital expenditures to develop.

Algeria

Algeria's total oil production should increase slightly by 1985. Although crude output will begin to decline around 1980, output of natural gas liquids (NGL) is projected to rise sharply enough in 1980-85 to more than offset the crude decline. The NGL production will increase in association with growing natural gas output to meet requirements for liquefied natural gas (LNG) sales. Oil exploration in Algeria has been disappointing; no oil finds of consequence have been made during the last 12 years.

Libya

Libyan oil production capacity has declined in recent years because investment has been kept to a minimum. Current capacity is about 2.3 million b/d, down from more than 3 million b/d in the early 1970s. Tripoli has several projects under way designed to boost output. Projects have been lagging, however, because of insufficient investment and technical problems, and they will barely offset declining production from older fields. All in all, Libyan oil output is unlikely to increase beyond 2.5 million b/d by 1985.

Others

The remaining members of OPEC—Qatar, Gabon, and Ecuador—share a similar fate. Each has relatively small oil reserves and little prospect for finding any substantial amount of additional reserves. Production from each of the three probably will be stable through 1985.

II. OPEC PRODUCTION SCENARIOS

We have developed three illustrative scenarios featuring different ways OPEC countries could allow their production to develop in 1978-85 (see table 2). The high and low scenarios establish a range of possible outcomes for total OPEC oil output. The medium scenario approximates what we judge to be the most likely level of OPEC output in 1978-85.

In these scenarios the projected ranges of production in Saudi Arabia, Kuwait, and Abu Dhabi reflect deliberate policy options. In other countries such as Iraq and Iran, the rather wide range on output projections through 1985 reflect technical considerations. In the other OPEC countries, the expected range of future production is relatively narrow.

Table 2

OPEC: Oil Production Scenarios [1]

Million b/d

	1977	1980	1982	1985
			High	
Total	**31.7**	**36.7**	**37.8**	**40.1**
Saudi Arabia	9.4	10.5	11.3	12.5
Iran	5.7	6.2	6.1	6.0
Iraq	2.3	3.1	3.5	4.0
Kuwait	2.0	3.3	3.3	3.3
Abu Dhabi	1.7	2.0	2.2	2.5
Other	10.6	11.6	11.4	11.8
			Medium	
Total	**31.7**	**34.4**	**35.6**	**36.4**
Saudi Arabia	9.4	9.5	10.5	10.5
Iran	5.7	6.0	5.8	5.5
Iraq	2.3	3.1	3.5	4.0
Kuwait	2.0	2.3	2.3	2.3
Abu Dhabi	1.7	1.9	2.1	2.3
Other	10.6	11.6	11.4	11.8
			Low	
Total	**31.7**	**33.1**	**33.0**	**33.3**
Saudi Arabia	9.4	8.8	8.8	8.8
Iran	5.7	5.8	5.5	5.0
Iraq	2.3	3.0	3.2	3.5
Kuwait	2.0	2.3	2.3	2.3
Abu Dhabi	1.7	1.6	1.8	1.9
Other	10.6	11.6	11.4	11.8

[1] Including natural gas liquids.

The highest of the three OPEC production scenarios is *not* a maximum based on technical feasibility for the key OPEC countries; rather, it is the upper end of a range that we believe encompasses *overall* outcomes of reasonable probability during the period. Specifically, it assumes:

- Saudi Arabia relaxes production restrictions and decides within the next year or so to make the necessary investment in capacity to increase sustained production to 12.5 million b/d by 1985.
- Kuwait removes all restrictions on production in the period to 1985 but does not expand capacity.
- Abu Dhabi removes production restrictions in 1979 and allows gradual increases in production to 2.5 million b/d by 1985.
- Iran's production drops only a little after 1980, to 6 million b/d by 1985.
- Iraqi oil production increases steadily to 4 million b/d by 1985.

In the medium case we assume:

- Saudi Arabia gradually makes necessary investments and relaxes some production restrictions, in order to produce at a sustained rate of 10.5 million b/d during 1982-85.
- Kuwait maintains the current annual production ceiling on the Kuwait Oil Company and gets 300,000 b/d as its share of Neutral Zone output.
- Abu Dhabi gradually allows production to increase to 2.3 million b/d by 1985.

- Iran's gas-injection program prevents output from dropping below 5.5 million b/d.
- As in the high scenario, Iraq raises production to 4 million b/d by 1985.

The low production scenario assumes:

- Saudi Arabia maintains an 8.8-million b/d limit on allowable production through 1985—8.5 million b/d for Aramco and 300,000 from the Neutral Zone it shares with Kuwait.
- Abu Dhabi maintains a ceiling of 1.6 million b/d until 1980 and allows increased production only from newly discovered reserves thereafter.
- Iran's capacity slips below 6 million in 1980 and slides gradually to 5 million b/d.
- Iraq expands to only 3.5 million b/d.
- Kuwait maintains its current production ceiling.

III. OECD DEMAND FOR OPEC OIL

Just as the production of OPEC countries is the key element in the worldwide supply of oil, the demand for oil imports by the OECD countries is the key determinant of world demand for OPEC oil. To establish a range of figures for OECD demand for OPEC oil in the 1978-85 period, our analysis examines supply and demand of all other forms of energy and treats OPEC oil as the balancing item. Energy demand in the four OECD regions—the United States, Japan, Western Europe,[4] and Canada—was estimated under varying real GNP growth assumptions (see table 3). In all cases, our baseline projections allow for the impact of past legislation on energy demand but do not incorporate savings from proposed legislation.

[4] Throughout this assessment Western Europe includes France, Italy, the United Kingdom, West Germany, Austria, Belgium, Luxembourg, Denmark, Finland, Greece, Iceland, Ireland, the Netherlands, Norway, Portugal, Spain, Switzerland, Sweden, and Turkey.

Table 3

OECD: [1] Real GNP Growth Assumptions [2]

	Average Annual Percent Change			
	1978 [3]	1979-81	1982-85	1978-85
OECD average 3.7 percent				
OECD	3.8	4.0	3½	3.7
United States	4¼ [4]	4.0	2¾	3.4
Japan	5¼	6.0	6.0	5.9
Western Europe	2¾	3¼	3¾	3.4
Canada	3¾	4.0	2½	3.2
OECD average 4.2 percent				
OECD	3.8	4¼	4.0	4.2
United States	4¼ [4]	4¼	3¼	3.8
Japan	5¼	6½	6½	6.3
Western Europe	2¾	3¾	4¼	3.9
Canada	3¾	4½	3.0	3.7

[1] Excluding Australia and New Zealand.

[2] These growth rates were calculated from projections of specific age population trends, projections of participation rates, and the use of historic GNP to employment relationships. They imply constant OECD unemployment assuming the historic relationship between employment and GNP growth (OECD average 4.2 percent) or, alternatively, constant unemployment assuming a decline in the historic relationship of productivity to GNP growth (OECD average 3.7 percent).

[3] Estimated.

[4] Official projection.

Domestic energy prices were assumed constant relative to the prices of other goods in Western Europe, Japan, and Canada. Canada's current energy policy calls for increases in domestic oil prices toward international levels by 1990 and for increases in domestic natural gas prices to an appropriate competitive relationship with oil. Rises scheduled so far, however, probably will have only a small impact on relative energy prices throughout the entire 1978-85 period. In the United States, where domestic energy prices are substantially below world market levels, we assumed that relative energy prices would rise 2.5 percent annually during the period through 1985. This is on the high side of what other energy analysts estimate will occur in the absence of further price deregulation.

Available nonoil energy supplies and domestic oil production were subtracted from energy demand in each OECD region to establish projected demand for oil imports.[5] Domestic supply projections reflect what we believe to be generally optimistic judgments as to what is feasible. For the United States, these judgments take into account some price increases, even in the absence of further price deregulation. Any additional price increases or other stimulative measures probably would not have much effect on production until the second half of the 1980s.

Energy production and consumption were calculated for primary energy sources such as crude oil and natural gas liquids, coal, natural gas, nuclear energy, and hydroelectric and geothermal energy.[6] All energy sources were converted to million barrels per day oil equivalent.

[5] Since we did not vary total OECD domestic energy supplies under each set of real GNP growth assumptions, our methodology implies that imported oil satisfies a rising share of energy demand at higher rates of economic growth. Projections of the future size and structure of fossil-fired electricity-generating capacity indicate that the OECD countries will have sufficient capacity to handle the quantities of oil that we project.

[6] See appendix A, dealing with methodology.

OECD Energy Demand in Perspective

In 1961-70, energy demand throughout the OECD expanded faster than real GNP while relative energy prices fell steadily. As the decline in relative prices slowed in 1971-73, the demand for energy rose less rapidly than real GNP in three of the four OECD regions. Then, in 1974-76, there was a period of sharp rises in relative prices, and GNP growth exceeded energy demand considerably (see figure 4).

The observed historical relationships between energy demand, real GNP, and relative energy prices in 1961-76 were quantified through single equation models of energy demand in each of the four OECD regions. In general, we found that for every 1-percent rise in real GNP, energy demand rose between 0.96 percent and 1.1 percent, while for every 1-percent jump in relative energy prices, energy demand dropped between 0.20 percent and 0.27 percent over time depending on the region. Although these results are theoretically reasonable and fit the historical data very well, it should be noted that other researchers, using different equation specifications and sample periods, have obtained different income and price elasticities. In the United States, for example, some studies have estimated substantially lower income and higher price elasticities than we found. Consequently, because a several-year projection magnifies the variation caused by parameter differences, our equation-predicted US energy demand for 1985 would be somewhat higher than that estimated by researchers finding lower income elasticities.[7]

As a rough test of the accuracy of our estimative procedures in predicting recent energy consumption, we calculated the change in US energy consumption projected for 1977 by our methodology and compared it with changes indicated by preliminary 1977 data. Our equation projected a 1.7 million b/d rise in 1977, while the preliminary actual rise was 1.5 million b/d. Preliminary 1977 energy demand data are not yet available for the other OECD regions.

The four regional equations were used to estimate the savings in energy use resulting from the large rise in relative energy prices since the oil embargo. Comparing actual energy demand with the demand that would have developed had prices held at 1973 levels indicates that the developed countries had achieved savings in energy consumption equal to 3.9 million b/d oil equivalent in 1976 (see figure 5). After growing sharply in 1974 as thermostats were lowered and other low-cost measures were implemented, energy efficiency improved less rapidly in 1975-76. France, for instance, showed no additional savings in 1976.

Most of the savings to date have been in the commercial and residential sectors of the developed countries. In most countries, industrial savings have been slow to materialize; capital stock turnover has been sluggish because of weak investment demand since 1973. The four major OECD regions all show somewhat different patterns of energy savings.

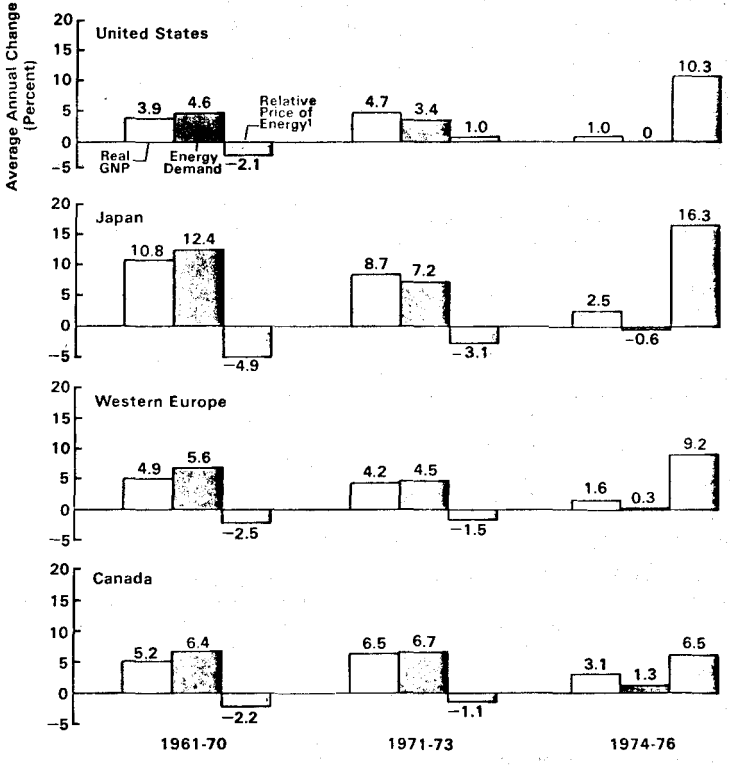
- In the United States, energy savings in 1976 are estimated at 1.6 million b/d (4 percent of consumption); motor fuel use per vehicle dropped sharply in 1974-76 and industrial energy use per unit of output in 1976 was substantially below preembargo levels.
- In Japan, where savings are estimated at 800,000 b/d in 1976 (12 percent of consumption), conservation has been confined to the residential, commercial, public service, and agricultural sectors, which have benefited from better insulation and lower inside temperatures. In the transportation sector, energy use per motor vehicle actually has risen since 1973 because of stricter auto emission standards, greater traffic congestion, and a trend toward heavier cars.

Of the larger West European countries, France has been the most successful. Legislation has reinforced the impact of higher prices; in particular, heating oil has been rationed since mid-1974. Although nonindustrial conservation has far outpaced that in other sectors, some improvement has been registered in industrial and transportation efficiency, and electricity generation conversion efficiency has improved. Italy has obtained sizable savings in the transportation

[7] See also appendix A.

Figure 4

OECD: Growth in Real GNP, Energy Demand, and Relative Price of Energy



1. Ratio of the index of aggregate price of energy to the GNP deflator.

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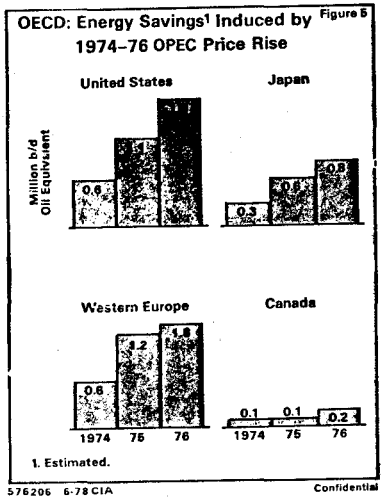


sector, reflecting the highest gasoline prices in Europe. In percentage terms, savings in West Germany have lagged those in France and Italy somewhat but kept ahead of those in Britain, where conservation receives a lower priority than development of domestic resources.

- Canada has achieved relatively little energy savings. The rise in domestic energy prices through 1976 was milder than elsewhere in the industrial countries—less than half the rise in Japan's relative energy prices, for instance.

OECD Energy Demand in the Years Ahead

To project OECD demand for energy through 1985, we combined the estimated relationships between each region's energy demand and its real GNP and relative energy prices with projections of those variables. Our equations probably capture most of the savings in energy demand due to past changes in relative prices and, in the case of the United States, projected changes. They do not, however, encompass the impact of government energy regulations newly in place or of projected demographic shifts. They may not capture *all* of the effects of past price increases on the energy efficiency of equipment, buildings, and other durable goods that will be introduced in future years. Quantifying these additional savings is extremely difficult and depends to a high degree on personal judgment. It should be stressed that altogether the range of error due to estimative techniques and to conservation uncertainties could be high.

Some additional savings in energy are likely in most OECD countries in the next several years irrespective of market conditions.

- In the **United States**, Congress has stipulated that average new car mileage in 1985 must reach 27.5 miles per gallon. The impact of this regulation on gasoline consumption, which accounts for about 20 percent of energy demand currently, will be reinforced by a sharp slowdown in the growth of the driving-age population in the next decade (see figure 6). Some industrial sources believe that these developments could trim as much as 2 million to 2.5 million b/d from potential energy demand. Other US measures adopted to date are expected to add small additional energy savings.

- **Japan** has done relatively little to encourage additional conservation. Tokyo's meatiest energy conservation measures focus on industry. The Japan Development Bank extends loans at interest rates slightly below commercial rates to those enterprises investing in energy-saving facilities and equipment. Funding for this program was only $70 million in the bank's 1977/78 budget, however. Small and medium-sized factories that add heat exchangers to existing furnaces are allowed to depreciate one-quarter of the investment in the first year.

- The potential for additional savings in Western Europe is spotty. **West German** legisla-

tion focuses on the residential sector. A contractor to the Ministry of Research and Technology estimates that new housing construction and home heating regulations eventually will save 540,000 to 640,000 b/d. France has placed more emphasis on conservation than most European countries and stands a good chance of reaching its total 1985 savings goal of 900,000 b/d. Contributing to this achievement will be non-price-induced conservation resulting from measures to regulate standards on new buildings, to provide financial incentives to promote retrofit, and to allocate $200 million in the current budget to help finance energy-saving industrial investments. The potential for non-price-induced conservation appears limited in Britain and Italy. London generally has not stressed conservation, though it does allow a 100-percent tax credit for the installation of insulation in industry. The normal capital equipment grant to less developed regions, moreover, has been extended to energy saving devices. Rome's conservation efforts have focused on higher taxes and prices, whose impact should be captured by the price term in our equation for Western Europe.

- Canada estimates it can save 140,000 b/d through the Canadian Home Insulation Program (CHIP) introduced in September 1977. CHIP has available $1.4 billion over seven years to provide grants of two-thirds the cost of home insulation materials to retrofit existing residential units.

Recognizing the difficulties of quantifying additional conservation effects, we judgmentally reduced our initial estimate of energy demand to develop baseline demand projections. After careful review of current energy legislation, we reduced 1985 energy demand in each of the OECD

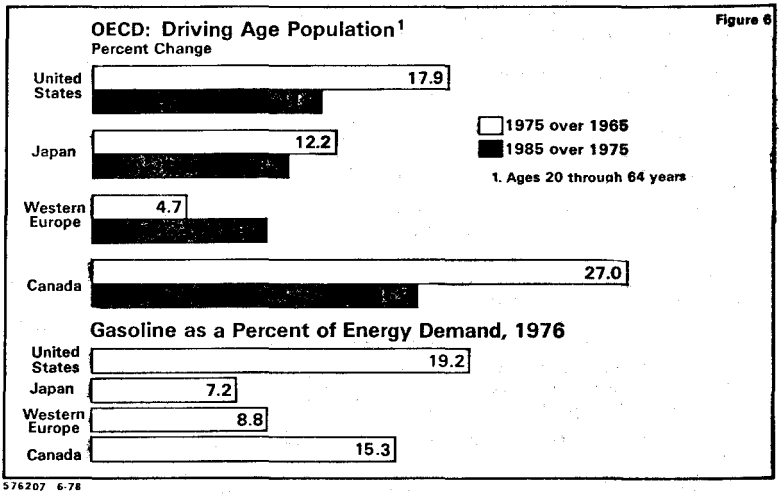


Figure 6

regions by 5 percent and assumed that the indicated savings rose linearly to this amount over 1977-85. Again, we caution that there is a considerable range of possible error surrounding both the results derived from our equations and the 5-percent allowance for additional savings. To the extent that currently proposed energy legislation leads to even further savings, future energy demand of course would be lower than our projections. For instance, the Department of Energy estimates that currently proposed legislation will reduce US energy demand sufficiently to trim approximately 2 million b/d from potential oil demand (about 4 percent of energy demand) by 1985. This would be about as much as the savings anticipated from the legislation adopted in 1976 to set automobile mileage standards.

Our methodology allows for a considerable degree of energy conservation. It implies an average 0.7-percent annual decline in the intensity of OECD energy use—that is, in the amount of energy needed to produce a unit of GNP in 1977-85. This is about one-half the rate of decline actually achieved in 1974-76 (see figure 7). It compares with a range of annual declines of 0.2 percent to 1.0 percent projected by other energy analysts.[8] Our methodology also assumes declining rates of savings in each of the four region's energy demand: real GNP ratios over the nine year period, compared with 1974-76 trends.

- In the United States, the ratio of energy demand to GNP is projected to decline at an annual rate of 0.8 percent in 1977-85 compared with a 1-percent annual drop in 1974-76.
- In Japan, the ratio of energy demand to GNP shows an annual rate of decline of 0.9 percent in 1977-85 relative to a 3-percent annual drop in 1974-76.
- In Western Europe, the projected future rate of decline in the ratio is 0.6 percent, down from a 1.3-percent annual drop in 1974-76.
- In Canada, where conservation is not a major policy objective, the ratio is projected to decline 0.2 percent a year, substantially less than in 1974-76.

To understand the broad implications of our OPEC oil supply estimates, we developed OECD energy demand scenarios related to two rates of real economic growth associated with constant OECD unemployment under alternative productivity assumptions. For our baseline scenario we estimated the GNP growth rate in each OECD region that would approximate the rate required to hold unemployment at near current levels. The resulting annual average for the OECD was about 4.2 percent in 1978-85. We incorporated into these estimates a number of factors bearing on future unemployment, such as the growth in the working-age population, projections of labor force participation rates, and the relationship observed in the 1970s between changes in real GNP and changes in employment (see table 4).

Table 4

OECD: [1] Baseline Energy Demand Scenarios [2]

Million b/d Oil Equivalent

		Projected		
	1977 [3]	1980 [4]	1982	1985
		3.7 percent OECD growth in real GNP, 1978-85		
Total	75.4	83.4	87.4	94.6
United States	38.4	42.9	44.4	46.9
Japan	7.3	8.4	9.1	10.6
Western Europe	25.3	27.1	28.6	31.5
Canada	4.4	5.0	5.3	5.6
		4.2 percent OECD growth in real GNP, 1978-85		
Total	75.4	84.2	89.3	98.0
United States	38.4	43.3	45.4	48.6
Japan	7.3	8.5	9.3	11.0
Western Europe	25.3	27.4	29.2	32.6
Canada	4.4	5.0	5.4	5.8

[1] Excluding Australia and New Zealand.

[2] To allow for the impact of existing energy legislation on each scenario, it is assumed that the resulting savings rise linearly to 5 percent in 1985. The scenarios imply constant OECD unemployment assuming the historical relationship between employment and GNP growth (OECD average 4.2 percent) or, alternatively, constant unemployment assuming a decline in the historic relationship of productivity to GNP growth (OECD average 3.7 percent).

[3] Estimated.

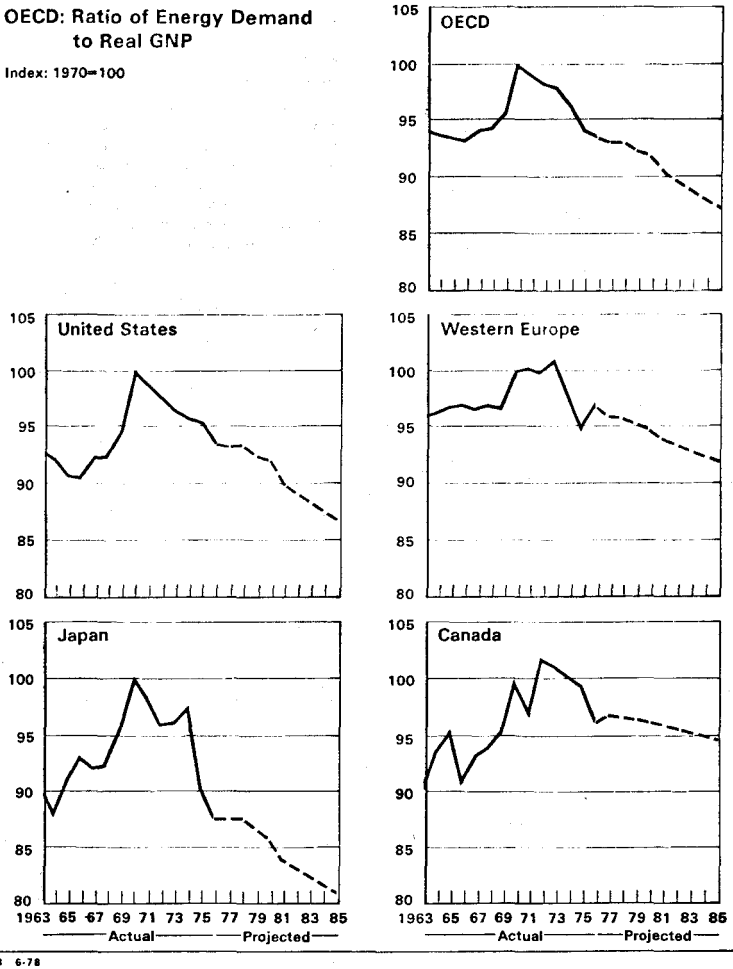
[4] Including additions to strategic oil reserves of 600,000 b/d for the United States and 100,000 b/d each for Japan and Western Europe.

[8] See appendix D for a discussion of comparative energy demand forecasts.

Figure 7

OECD: Ratio of Energy Demand to Real GNP

Index: 1970=100



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Because substantial changes in working-age population growth will occur in three of the OECD regions between now and the early 1980s, we varied the growth rates required to hold their unemployment constant. The source of our population projections (United Nations) presents these projections only at five-year intervals, leading to a substantial discontinuity in our growth rates between 1981 and 1982. Use of year-by-year population projections would of course lead to a smoother transition of the required growth rates. These changes in working-age population growth dictated a lower constant unemployment GNP growth rate in the United States and Canada after 1981 and a higher one in Western Europe.

Because of the possibility of changes in some of the historical trends and relationships, the calculated 4.2-percent average annual growth in the OECD in 1978-85 should be regarded as *merely indicative* of GNP growth likely to be required for constant unemployment, not as precise forecasts. For example, in the case of the United States, many observers believe the constant unemployment growth rates to be lower than the ones we have used, particularly in the 1978-81 period. These alternative views appear to relate (a) projections of lower labor-force participation and (b) beliefs that, because of reduced rates of capital formation and other factors, given GNP gains may require higher employment changes in lieu of gains in productivity. To take account of the possibility that employment may rise more rapidly in relation to GNP in the future than in the past, we ran an alternative set of GNP growth assumptions 0.5 percent lower (OECD average 3.7 percent annually in 1978-85) than the baseline scenario.

The lower of our growth scenarios incorporates GNP growth rates averaging 3.7 percent annually for the OECD in 1978-85. In most cases the rates are close to those anticipated by many economic forecasters, although the 1982-85 US and Canadian GNP increases are on the low side. Aside from the energy issue, pessimism about future economic growth is warranted by (a) bleak investment prospects due to low profits and business uncertainty and (b) cautious government economic policies in the face of large payments and budget deficits. In this scenario, energy demand in the developed countries rises at an annual rate of 2.9 percent in 1978-85 to 94.6 million b/d of oil equivalent in 1985.

Under our higher growth scenario, energy demand in the OECD would rise from 75.4 million b/d of oil equivalent in 1977 to 98 million b/d in 1985.[a] The GNP growth rates used in this scenario are generally a shade on the high side of what most forecasters expect for the OECD in 1978-85—averaging 4.2 percent annually—and the growth rate for energy consumption is 3.3 percent.

OECD Energy Supplies

Our estimates for OECD energy supplies in 1978-85 are based on a detailed analysis of the plans and prospects for each energy source in the four OECD regions. Specifically, we reviewed (a) government development and resource management policies, (b) the estimated resource base, (c) existing and firmly committed trade agreements, and (d) the leadtimes required to bring projects on line. Essentially, we prepared "best estimates" of what can be achieved under current legislation if no significant slippage in construction schedules occurs.

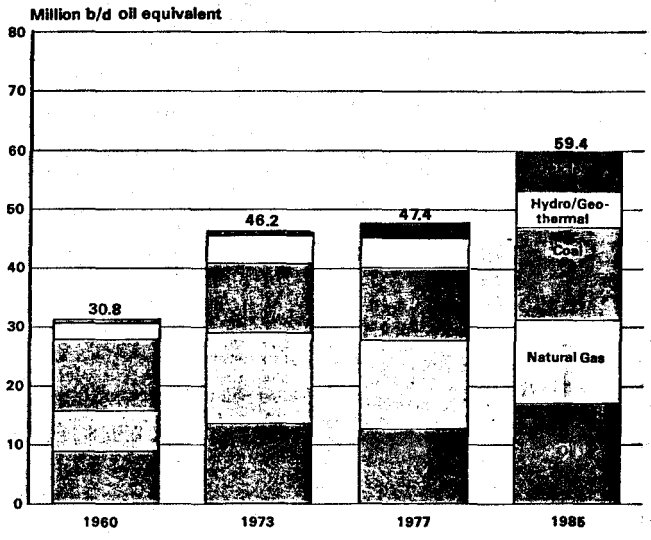
OECD energy production is expected to grow on average more than 3.9 percent a year in 1978-80, slowing sharply to about 2 percent a year in the 1981-85 period (see figure 8). The slowdown will primarily reflect deceleration in the growth of OECD oil production after 1980 as increments from North Sea and Alaskan North Slope production drop off. Among nonoil energy sources the largest gains foreseen throughout the next eight years are for nuclear energy and coal. Natural gas production is expected to stagnate at best after 1980. By 1985 between 3 million and 4 million b/d of oil equivalent in coal and natural gas imports are expected to supplement domestic OECD energy output (see tables 5 and 6).

Increases in OECD oil production between now and 1985 will come mostly from the North

[a] See appendix D for a discussion of comparative energy demand forecasts.

Figure 8

OECD: Energy Production by Type



1. Including natural gas liquids.

576209 6-78

Sea, though at a declining rate after 1980. British output, 800,000 b/d last year, should quadruple in the next eight years. Production from the British sector is expected to surge by 500,000 b/d this year and next; increments are expected to fall off sharply thereafter. Norwegian production is projected to double to 600,000 b/d this year and to rise slowly thereafter to about 1.3 million b/d in 1985. Starting in 1980, Statfjord, the largest field found in the North Sea to date, will augment Ekofisk production. Reserves are ample to support these estimated crude oil production levels. Combined reserves of some two dozen fields discovered in British waters amount to about 20 billion barrels. Aggregate reserves of the Statfjord and Ekofisk complex in the Norwegian sector could measure up to 8 billion barrels. Production rates through 1985 are based on reasonably well-established development planning.

Only small increases are expected in US and Canadian oil production.

Table 5

Non-OPEC Free World Countries: Oil Production [1]

Million b/d

		Projected		
	1977[2]	1980	1982	1985
Total	**17.6**	**22.2**	**23.7**	**26.5**
United States	9.8	10.4	10.2	10.3
North Slope	0.3	1.5	1.6	2.0
Other	9.5	8.9	8.6	8.3
Western Europe	1.5	3.3	4.0	4.8
United Kingdom	0.8	2.1	2.6	3.0
Norway	0.3	0.8	1.0	1.3
Other	0.4	0.4	0.4	0.5
Canada	1.6	1.7	1.7	1.9
Other Developed	0.5	0.5	0.5	0.5
LDCs	4.2	6.3	7.3	9.0
Mexico	1.1	2.3	2.9	3.9
Brazil	0.2	0.2	0.4	0.5
Egypt	0.4	0.7	0.9	1.0
Other	2.5	3.1	3.1	3.6

[1] Including natural gas liquids.
[2] Estimated.

- US output probably will inch up to 10.3 million b/d in 1985. This projection compares with a range of 9.5 million b/d to 10.5 million b/d being forecast by most oil companies, the Department of Energy, and the Congressional Research Service. Alaskan North Slope output, which is scheduled to jump from 300,000 b/d in 1977 to 2 million in 1985, should more than offset a continued decline from other sources. Since many US oil exploration efforts have been in older, mature areas, increased drilling has not led to an increase in reserves. It has, however, helped slow the rate of decline in production outside the North Slope. Although the United States has additional offshore potential, supplies from this source are not likely to be substantial in the period to 1985.

- After dropping in 1974-76, Canadian oil output leveled off last year and may rise a little by 1985. Increased drilling in shallow oil deposits in Alberta offset the decline in older fields last year. No major deposits have turned up, although finds in the West Pembina part of Alberta are promising. The Pembina find should account for 200,000 to 300,000 b/d of new production in the 1982-85 period. Synthetic oil production from tar sands is expected to jump from 50,000 b/d in 1977 to 300,000 b/d in 1985. Oil production from Canadian Arctic deposits is not likely to come onstream in the period to 1985 because of the high cost of developing and distributing these supplies.

OECD natural gas production may fall off a little, to about 14 million b/d oil equivalent in 1985. Our estimate of US domestic output of natural gas at 8.4 million b/d oil equivalent in 1985 assumes a continued fall in production—with output exceeding reserve additions each year—and no increase in finding rates. No Alaskan North Slope gas is projected to be available before 1985. Most forecasters expect US gas output in the range of 7 million to 9 million b/d oil equivalent by 1985.

West European production of natural gas should grow about 15 percent. Although Dutch gas, which now covers 45 percent of West European consumption, will be held back for conservation reasons, start-up production in the Brent Field plus full utilization of the Frigg Field will help boost British North Sea output a fifth by 1985. Norwegian North Sea production is expected to jump from 28,000 b/d oil equivalent last year to 500,000 b/d in the early 1980s. Canada also expects some rise in natural gas production. Recent discoveries, encouraged by federal exploration incentives, lower taxes, and royalties at the federal and provincial levels, should boost Canadian output by the early 1980s. Japan has some potential for higher natural gas production offshore, but exploration and development efforts are hampered by unresolved, overlapping Japanese, Chinese, and Korean claims.

OECD coal production is expected to rise from 12.3 million b/d oil equivalent in 1977 to 15.4 million b/d in 1985. On the basis of current US legislation we project an increase in US coal output from 7.5 million b/d oil equivalent in 1977 to 10.4 million b/d in 1985 with nearly all the growth in US consumption coming from the generation of electricity. This projection is nearly

Table 6

OECD: [1] Energy Production and Net Nonoil Energy Imports

Million b/d Oil Equivalent

		Projected		
	1977 [2]	1980	1982	1985
Total energy production	47.4	53.2	55.5	59.4
Oil [3]	12.9	15.4	15.9	17.0
Natural gas	15.0	15.2	14.9	14.1
Coal	12.3	13.2	14.0	15.4
Hydro/geothermal	5.0	5.5	5.8	6.3
Nuclear	2.2	3.9	4.9	6.6
United States	30.1	31.6	32.3	34.1
Oil [3]	9.8	10.4	10.2	10.3
Natural gas	10.0	9.4	9.0	8.4
Coal	7.5	8.3	9.1	10.4
Hydro/geothermal	1.5	1.7	1.7	1.8
Nuclear	1.3	1.8	2.3	3.2
Japan	1.0	1.3	1.3	1.6
Oil	Negl	Negl	Negl	Negl
Natural gas	0.1	0.1	0.1	0.1
Coal	0.3	0.3	0.3	0.3
Hydro/geothermal	0.5	0.5	0.5	0.6
Nuclear	0.1	0.4	0.4	0.6
Western Europe	11.6	15.0	16.3	17.8
Oil [3]	1.5	3.3	4.0	4.8
Natural gas	3.3	3.8	3.8	3.8
Coal	4.2	4.3	4.3	4.3
Hydro/geothermal	1.9	2.1	2.2	2.4
Nuclear	0.7	1.5	2.0	2.5
Canada	4.7	5.3	5.6	5.9
Oil [3]	1.6	1.7	1.7	1.9
Natural gas	1.6	1.9	2.0	1.8
Coal	0.3	0.3	0.3	0.4
Hydro	1.1	1.2	1.4	1.5
Nuclear	0.1	0.2	0.2	0.3
Total net nonoil energy imports	1.7	2.7	3.1	3.7
Natural gas	0.6	1.5	1.8	2.3
Coal	1.1	1.2	1.3	1.4
United States	−0.1	0.1	0	0.3
Natural gas	0.5	0.8	0.8	1.1
Coal	−0.6	−0.7	−0.8	−0.8
Japan	1.0	1.3	1.4	1.6
Natural gas	0.2	0.4	0.4	0.5
Coal	0.8	0.9	1.0	1.1
Western Europe	1.3	1.8	2.1	2.3
Natural gas	0.4	0.8	1.0	1.1
Coal	0.9	1.0	1.1	1.2
Canada	−0.5	−0.5	−0.4	−0.5
Natural gas	−0.5	−0.5	−0.4	−0.4
Coal	Negl	Negl	Negl	−0.1

[1] Excluding Australia and New Zealand.
[2] Estimated.
[3] Including natural gas liquids.

the same as that of a recent study by the Congressional Research Service—*US Energy Demand and Supply: Limited Options, Unlimited Constraints*. Passage of new legislation to provide additional incentives to public utilities and industrial firms could stimulate some additional coal consumption, if environmental, labor, and transportation problems related to production are overcome.

West European, Canadian, and Japanese coal output will barely rise.

- West European coal is relatively expensive to mine because it is found in deep, thin seams; in some countries, imported coal prices undershoot domestic ones by as much as a third. Continuing declines in West German and French coal output should be offset by an increase in British production; together these countries account for more than 90 percent of Western Europe's coal. Small gains are expected elsewhere in Europe, notably in Spain, Greece, and Turkey.
- Substantially greater Canadian coal production is also unlikely. Expansion is impeded by (a) lack of transportation facilities to deliver western coal to eastern markets, (b) delays in export contracts, which had supported new development, and (c) Ottawa's failure to reconcile competing energy and population goals.
- Japan's coal reserves are located in remote, mountainous areas and scattered in deep-lying structures. Production costs currently exceed the market price for coal, and an acute shortage of skilled labor further constrains Japanese production capability.

Nuclear energy is facing increasing political and legal pressures in the developed countries. The growing debate about the efficiency and desirability of nuclear power coupled with lower projected increases in electricity demand and the rapidly rising cost of nuclear facilities have already substantially reduced expectations of nuclear availability in 1985 (see table 7). Estimates of future capacity continue to fall as construction schedules stretch out. It now appears, however, that barring a major disruption to the nuclear industry such as a permanent construction or operating moratorium in a major country, sizable further reductions in forecast capacity are unlikely. Hence, by 1985 nuclear-generated electricity should be contributing the equivalent of 6.6 million b/d oil to OECD energy production, triple that of 1977.

Installed generating capacity in the United States is expected to exceed 100,000 megawatts by the mid-1980s. At about 3 million b/d oil equivalent, nuclear-generated electricity will account for nearly 10 percent of US energy supplies in 1985. Nuclear expansion will account for more than three-fourths of the rise in Japan's nonoil energy supplies in 1977-85. An installed capacity of 22,000 to 23,000 megawatts on line in 1985—well below government projections—should guarantee nuclear electricity production on the order of 600,000 b/d oil equivalent, given early solution of the operating problems now plaguing a large share of existing Japanese nuclear capacity. In Canada active federal promotion of nuclear energy should add nearly 5,000 megawatts of capacity in the next eight years, mostly in Ontario.

In Western Europe, France is setting the nuclear expansion pace.

- Direct government control over the domestic energy market will enable Paris to boost nuclear power capacity far above that in any other West European country. By 1985, French nuclear capacity will reach 31,000 megawatts, compared with 4,600 megawatts in 1977.
- In West Germany, where energy markets operate more freely than in France, nuclear capacity should grow by 14,000 megawatts, reaching 20,000 megawatts by 1985. This is substantially less than the government planned only a few years ago. Law suits by environmental groups and strict state (land) requirements for the disposition of nuclear wastes have halted construction of many plants and postponed starts on many others.
- The United Kingdom, a pioneer in nuclear power, plans little increase in nuclear energy production. Ample domestic supplies of coal,

Table 7

OECD: Past Projections of 1985 Nuclear Generating Capacity

Thousand net megawatts

	Sep 1970[1]	Aug 1973[2]	Apr 1975[3]	Dec 1975[4]	Feb 1976[5]	Aug 1976[6]	Jan 1977[7]	Dec 1977[8]
Total	562.8	542.3	486.4	416.1	399.8	330.6	314.5	239.8
United States	277.0	280.0	204.5	179.0	180.0	147.0	152.0	101.0
European Community	148.4	134.2	149.3	136.2	128.5	105.7	85.8	78.7
Other Europe	54.1	50.1	53.4	45.2	38.3	35.1	28.8	27.1
Japan	60.0	60.0	60.0	41.0	41.0	30.0	35.1	24.0
Canada	18.0	15.0	19.2	14.7	12.0	12.8	12.8	9.0
Australia and New Zealand	5.1	3.0		...	...	...	...	...

[1] OECD European Nuclear Energy Agency/International Atomic Energy Agency, *Uranium Resources, Production, and Demand*, Paris, September 1970.

[2] OECD Nuclear Energy Agency/International Atomic Energy Agency, *Uranium Resources, Production, and Demand*, Paris, August 1973.

[3] OECD International Energy Agency, IEA/SLT (75)40, *Report to the Standing Group on Long-Term Cooperation: Subgroup on Enriched Uranium Supply*, Paris, 15 April 1975.

[4] OECD Nuclear Energy Agency/International Atomic Energy Agency, *Uranium Resources, Production, and Demand*, Paris, December 1975.

[5] OECD International Energy Agency, updated *Energy Prospects to 1985* (working paper), Paris, 11 February 1976.

[6] OECD Combined Energy Staff, *Long-Term Energy Assessment* (working paper), Paris, 6 August 1976.

[7] OECD, *World Energy Outlook*, Paris, January 1977.

[8] OECD Nuclear Energy Agency/International Atomic Energy Agency, *Uranium Resources, Production, and Demand*, Paris, December 1977.

oil, and natural gas have obviated the need for near-term nuclear expansion.

Other OECD energy sources are expected to increase moderately in the next several years. All the major OECD regions plan some expansion in hydroelectric/geothermal electricity, which should up OECD output from these sources to 6.3 million b/d in 1985. The total contribution of solar energy, wind, and other exotic energy sources in 1985 will be quite small, probably less than 50,000 b/d oil equivalent. Existing solar techniques that are cost effective at current prices—construction to take maximum advantage of solar heat and use of solar power to heat water—probably will continue to be introduced only slowly.

Domestic OECD energy sources will continue to be supplemented by net imports of coal and natural gas—3.7 million b/d oil equivalent in 1985, compared with 1.7 million b/d last year. The United States, Western Europe, and Japan will all import some natural gas in this period, mostly from OPEC members. Japan hopes to double liquefied natural gas (LNG) imports to 500,000 b/d oil equivalent in 1985 to satisfy the goal of diversifying energy sources and using clean fuels. Because of the enormous costs and complex technology involved, the Japanese have committed themselves to only a few LNG projects overseas. Storage and transportation constraints will also affect the rate at which Japan can increase its LNG imports. West European natural gas imports are expected to more than double by 1985, much in the form of LNG from Algeria. Soviet natural gas sales to Western Europe should also mount (from about 850,000 to 1.85 million b/d oil equivalent), giving the USSR a 50-percent share in Europe's natural gas imports by 1985.

Net OECD coal imports are expected to inch up, to 1.4 million b/d oil equivalent in 1985. West European coal imports—which come from South Africa, Poland, and Australia as well as from the United States—should grow moderately. Large increases seem unlikely because the steel industry, which accounts for 40 percent of coal

consumption, is unlikely to grow rapidly, and little increase is planned in coal-burning, electric power capacity. Japan's coal imports also should show no more than moderate gains for similar reasons.

OECD Net Oil Import Demand

Subtracting domestic OECD energy production and net nonoil energy imports from our energy demand scenarios yields a range of 31.5 million to 34.9 million b/d for net OECD oil import demand in 1985, depending on the underlying rate of GNP growth (see table 8). In both scenarios, the growth of net OECD oil import demand accelerates in 1980-82, reflecting the slowing in the growth of domestic oil production.

- Under the lower GNP growth assumptions, which are close to those used by several industrial energy forecasters, net OECD oil imports would be 31.5 million b/d in 1985, of which 12.5 million b/d would be imports by the United States.
- Under the higher growth scenario, net oil imports would amount to 34.9 million b/d in 1985 assuming that adequate oil supplies existed to meet this demand; US oil import demand would reach 14.2 million b/d, an amount that would press hard against available port capacity.

Table 8

OECD:[1] Net Oil Import Demand [2]

Million b/d

		Projected		
	1977 [3]	1980 [4]	1982	1985
	3.7 percent OECD growth in real GNP, 1978-85			
Total	26.3	27.5	28.8	31.5
United States	8.4	11.2	12.1	12.5
Japan	5.3	5.8	6.4	7.4
Western Europe	12.4	10.3	10.2	11.4
Canada	0.2	0.2	0.1	0.2
	4.2 percent OECD growth in real GNP, 1978-85			
Total	26.3	28.3	30.7	34.9
United States	8.4	11.6	13.1	14.2
Japan	5.3	5.9	6.6	7.8
Western Europe	12.4	10.6	10.8	12.5
Canada	0.2	0.2	0.2	0.4

[1] Excluding Australia and New Zealand.
[2] The scenarios imply constant OECD unemployment assuming the historic relationship between employment and GNP growth (OECD average 4.2 percent) or, alternatively, constant unemployment assuming a decline in the historic relationship of productivity to GNP growth (OECD average 3.7 percent).
[3] Estimated.
[4] Including additions to strategic oil reserves of 600,000 b/d for the United States and 100,000 b/d each for Japan and Western Europe.

IV. NON-COMMUNIST DEMAND FOR OPEC OIL OUTSIDE THE OECD

As the next stage in our analysis, we estimated the expected demand for OPEC oil in the non-OPEC LDCs and in a few industrial countries not covered in the OECD section. To simplify the analysis and keep its focus on the policy tradeoffs in the developed countries, we chose to make only single, most likely estimates about future demand for OPEC oil among these countries. Because of data inadequacies, the remainder of the non-OPEC, non-Communist world could not be treated on exactly the same basis as the developed countries. Instead, we looked at the historical relationship between economic activity as measured by gross domestic product (GDP) and oil consumption individually for 11 large oil-consuming LDCs, the remaining non-OPEC LDCs, and four developed countries.

Net Oil Import Demand of the Non-OPEC LDCs

We expect that the non-OPEC LDCs as a group will require less imported oil in 1985 than they do today—2.3 million b/d compared with 3 million b/d in 1977. It is rapidly increasing Mexican oil output, however, that masks growing import dependence by most non-OPEC LDCs. Mexico's exports are expected to grow from some 250,000 b/d last year to about 2.7 million b/d in 1985 (see table 9).

We expect oil consumption in the non-OPEC LDCs to continue to grow rapidly in 1978-85. In many of these countries the share of industry in national output is rising, making reductions in oil usage difficult. Overall, we estimate non-OPEC LDC oil demand will rise from an estimated 7.2 million b/d last year to more than 11 million b/d in 1985. These demand estimates assume that the non-OPEC developing countries as a group achieve real GDP growth of 4.5 percent annually in 1977-85. This economic growth rate approximates four-fifths of the historical ones, although wide variations occur among individual LDCs. It is consistent with a relatively sluggish growth rate in the developed countries.

Domestic oil production in the non-OPEC LDCs is projected to increase from 4.2 million b/d in 1977 to 6.3 million b/d in 1980 and 9 million b/d in 1985 (see figure 9). The largest gains will be in Mexico and Egypt, with smaller increases in India, Brazil, and Brunei-Malaysia. Production of oil and natural gas liquids in Mexico should rise from more than 1 million b/d last year to about 2.3 million b/d in 1980 and 3.9 million b/d in 1985. Egyptian oil output could reach 700,000 b/d in 1980 and 1 million b/d by 1983-84.

Discovery of vast oil reserves in Tabasco and Chiapas States of southeastern Mexico in 1972 turned around a rapidly deteriorating supply

Table 9

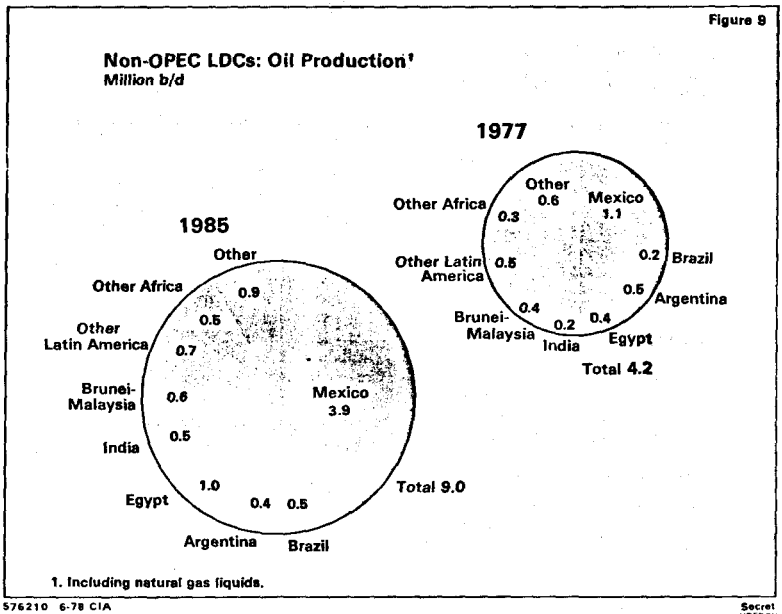
Non-OPEC LDCs: Net Oil Import Requirements

Million b/d

		Projected		
	1977 [1]	1980	1982	1985
Total				
Production [2]	4.2	6.3	7.3	9.0
Consumption	7.2	8.4	9.5	11.3
Net oil imports	3.0	2.1	2.2	2.3
Of which:				
Brazil				
Production [2]	0.2	0.2	0.4	0.5
Consumption	1.0	1.2	1.5	1.8
Net oil imports	0.8	1.0	1.1	1.3
Mexico				
Production [2]	1.1	2.3	2.9	3.9
Consumption	0.8	1.0	1.1	1.2
Net oil imports	−0.3	−1.3	−1.8	−2.7
Egypt				
Production [2]	0.4	0.7	0.9	1.0
Consumption	0.2	0.2	0.2	0.2
Net oil imports	−0.2	−0.5	−0.7	−0.8

[1] Estimated.
[2] Including natural gas liquids.

Figure 9



outlook. Pemex, the state oil company, launched a crash development program for the new oil deposits and Mexico regained its former status of a net exporter of crude by September 1974. Production of oil increased to more than 1 million b/d by late 1977.

Most recent oil reserve estimates for the onshore Reforma Fields in southeastern Mexico fall within a range of 20 billion to 60 billion barrels. At least 20 fields have been discovered onshore where at least 65 more structures are unexplored. Six fields with about 130 active wells are currently producing almost 750,000 b/d. Offshore, Pemex found four oil deposits in the "Chac" area, 75 kilometers north of Cuidad del Carmen, where another 60 or so structures remain undrilled.

Egypt's oil potential is greater than that of most non-OPEC LDCs. International oil companies generally have a high regard for Egyptian potential, particularly in the Gulf of Suez area where four major discoveries already have been made. We expect Egypt's oil will be developed at a moderate pace as long as exploration rights in the Gulf of Suez remain in doubt because of Israeli claims. Given the uncertainty over the political situation, Egyptian oil output probably

will not reach 1 million b/d until 1983 or 1984 compared with Cairo's projections of 1 million b/d in 1980.

Other Developed Countries

The prospects for production in the other developed countries—Australia, Israel, New Zealand, and South Africa—are not encouraging. In Australia, the only major oil producer in the group, oil production is expected to level off at about 500,000 b/d during the 1978-85 period. Overall, the net oil import position of this group probably will worsen from 700,000 b/d in 1977 to 1.3 million b/d in 1985.

V. COMMUNIST COUNTRIES IN THE OIL MARKET

We project a decline in Soviet oil production during 1981-85 to a level that should meet Soviet requirements but not leave a surplus for exports. Since Eastern Europe, Cuba, Vietnam, North Korea, and Mongolia are deficit areas, we expect that the Soviet change will shift the Communist countries as a group from a net oil export position to a net import role. How much they will import by 1985 is extremely uncertain. Our projections are affected not only by uncertainties in projections of both production and consumption but also by the fact that oil imports of even relatively small magnitude by world standards would involve a heavy drain on the limited foreign exchange earnings of the Communist countries. Considering the likely oil demand and supply conditions the Communist countries will face and plausible policy choices on their part, we believe that balance-of-payments constraints would limit net oil imports by the Communist countries to about 2.5 million b/d by 1985 assuming that real oil prices remain constant (see figure 10). Moreover, even if the Communist countries somehow avoid any net oil imports, the effect on world oil supply is only to postpone the projected arrival of demand pressures by one year.

The Soviet Oil Problem

Although the USSR has maintained its position as the world's largest oil producer—10.9 million b/d in 1977—the rate of growth of oil output has begun to slow markedly. In 1977, Soviet oil production increased only about 500,000 b/d. This was the smallest absolute rise since 1972 and the lowest rate of growth in the entire postwar period. Output is now declining in all of the major Soviet oil-producing regions except West Siberia, and production gains there promise to be much more difficult now that the giant Samotlor Field is reaching its peak (see figure 11).

The Samotlor Oilfield alone has accounted for the bulk of the growth in Soviet oil production over the past five to six years. Development of other, small, West Siberian fields is lagging behind plan. During 1976-80 at least six to eight new fields per year were to begin commercial production to compensate for the leveling off of Samotlor's output. However, in 1976 and 1977 only about five fields per year were added, mainly because of failure to meet schedules for massive drilling and infrastructural tasks.

More important, output in the Samotlor Field is likely to begin to decline by about 1980 and to fall substantially during 1982-85, while the decline already under way in other major producing regions will accelerate as reserves are depleted. As a result we believe that overall Soviet oil output could peak by 1980 and almost certainly will begin to decline rather sharply in the early 1980s. For this estimate, we project oil output of 10 million b/d in 1985, but we believe that this is the upper end of the range of reasonable possibilities assuming that exploration is relatively successful, development drilling goes well, and the Soviets can import needed equipment and technology. If things go poorly for them, output could fall as low as 8 million b/d.

Maximum production of alternative fuels—natural gas and coal—will only partially compensate for the decline in oil output in the short run. The Soviet natural gas industry has ended a boom phase in its development and is entering an era of slower growth. Soviet coal production already is lagging far below targets.

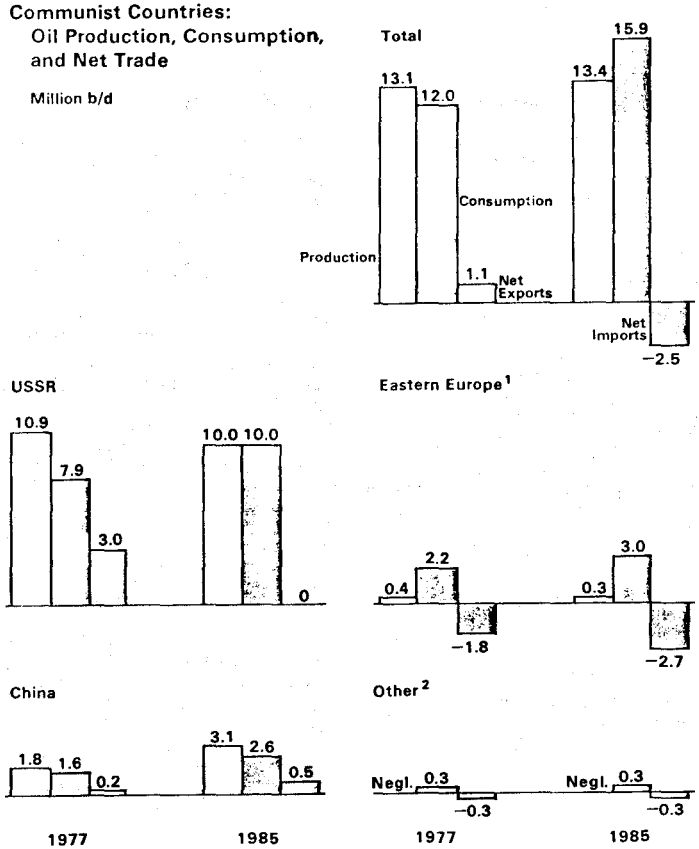
Although gas reserves are large and yearly output goals were overfulfilled in 1976 and 1977, a future slowdown is likely.

- Significant growth potential now is more concentrated in a single region than at any

Figure 10

Communist Countries: Oil Production, Consumption, and Net Trade

Million b/d



1. Including Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, Romania, and Yugoslavia.

2. Including Albania, Cuba, Cambodia, Laos, Mongolia, North Korea, and Vietnam.

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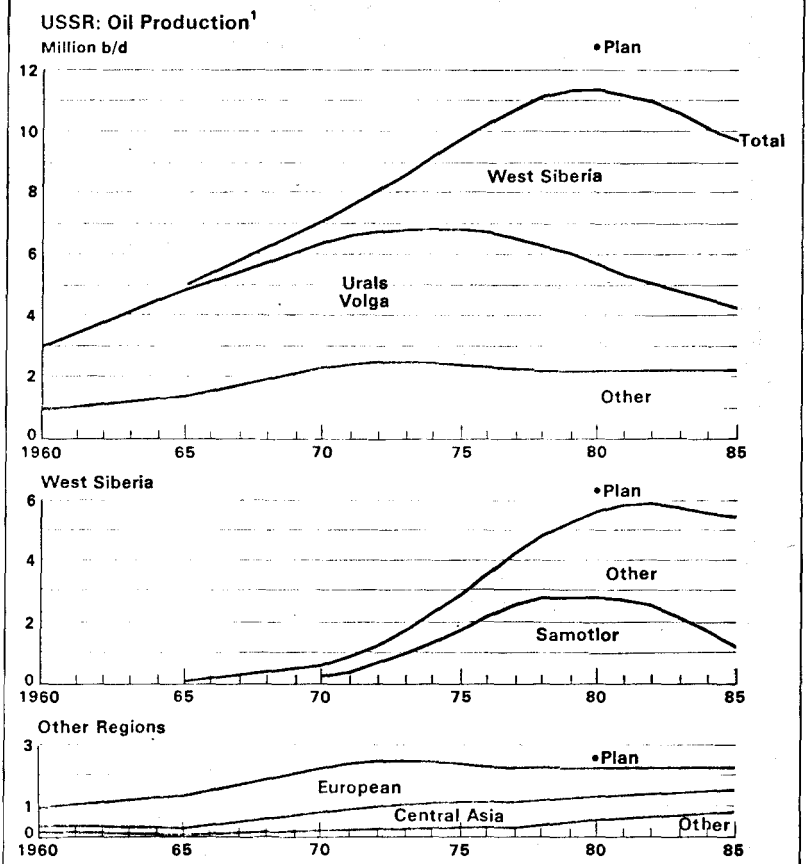
Figure 11



1. Including natural gas liquids.

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time since the Soviet gas industry began its rapid growth in the mid-1960s. At present, the most promising area is northern Tyumen Oblast in West Siberia. The cost and physical difficulty of developing deposits in very inhospitable terrain and piping the gas thousands of kilometers for domestic use or for export pose unprecedented problems. Poor infrastructure and harsh Arctic conditions will hinder drilling, production, and pipeline construction and will prevent the Soviets from tapping the huge reserves as quickly as they would like.

- Combined production from the country's other major gasfields in the Ukraine, North Caucasus, and Uzbekistan peaked in 1976, declined for the first time in 1977, and is scheduled to drop even further in the next few years.

The USSR has vast reserves of coal, but as with oil and gas, many of the deposits in European Russia are nearing exhaustion and are becoming more costly and difficult to work. Most new deposits are far to the east of industrial centers in the European part of the country, and many of the more accessible ones in the eastern regions are of poor quality. Coal output has increased only about 2 percent per year for the past two decades, and the planned average annual increases of about 3 percent for 1976-80 are not being achieved. Shortages of railcars for coal transport, poor use of the labor force, and lagging additions to new mining capacity are major bottlenecks. As new mines are opened in Siberia, transportation will become an increasingly difficult problem.

Reducing the growth of energy consumption in the USSR without a severe impact on the economy will be extremely difficult. [10] The pattern of energy consumption is substantially different from that in Western industrial countries and is one that makes large energy savings more difficult. The highly energy-intensive iron and steel industry alone accounts for nearly 13 percent of Soviet energy consumption, compared with only about 3 percent in the United States. In Western countries transportation and residential energy use is large, and the potential for energy savings in these uses is great. In the USSR many of the techniques now being discussed in the West to save energy in industry and households are already employed on a wide scale. Most urban space heating in the USSR, as well as large amounts of industrial process heat, are provided through cogeneration. In the West only a relative handful of cogeneration plants exist (mostly in Sweden and West Germany) while the USSR has more than a thousand. The overwhelming bulk of intercity freight traffic in the USSR is shipped on rail lines rather than by truck, as in the United States and Western Europe. As for passenger autos, the USSR has one for every 40 to 50 inhabitants, compared with more than one for every two inhabitants in the United States and Canada and one for every four to five in Western Europe.

Because of the consumption structure, major energy savings will have to be obtained largely by upgrading industrial technology or by a major shift in output away from heavy industry toward light industry and services. Neither would be easy. Upgrading technology is a very time-consuming, capital-intensive process. A shift away from heavy industry such as iron and steel would be contrary to the view of the dominant Soviet interest groups.

Real GNP growth has been dropping in the USSR and is expected to drop further during the 1980s. We project real GNP increases of about 4 percent a year in 1976-80 and 3 to 3.5 percent a year in 1981-85. [11] Soviet energy consumption typically has grown slightly faster than GNP in most recent years as well as in the 1960s. Given the limited potential for energy conservation, total energy demand probably will grow at essentially the same rates as GNP during 1981-85. [12]

[10] See appendix E for a more detailed discussion of energy supply and consumption in the USSR.

[11] The USSR faces serious economic strains in the decade ahead. Apart from the energy problem, the slowdown in growth is expected because of a sharp reduction in the growth of the labor force, declining rates of capital productivity, an inefficient and undependable agriculture, and a limited capacity to earn hard currency to pay for needed technology imports and intermittent massive grain purchases. A detailed discussion of Soviet economic problems was contained in *Soviet Economic Problems and Prospects*, ER 77-10436, July 1977.

[12] See appendix E.

The impending decline in oil production, coupled with the growth of GNP, will leave the USSR unable to produce enough energy during 1981-85 to meet domestic needs and at the same time to maintain a substantial net export position. We expect the growth rate for energy production to be about half that for demand. The USSR will, therefore, have to greatly reduce its net exports of energy. In 1976 they were 3.3 million b/d in oil equivalent. By 1985, sustaining even 1 million b/d will be difficult. We expect most net energy exports by 1985 to be in the form of natural gas. At that time, Soviet oil production and consumption may be roughly in balance. Continued Soviet oil exports to the other Communist countries would, therefore, have to be covered by imports from the West.

Energy-Poor Eastern Europe

Because of the paucity of domestic energy resources, about 80 percent of the oil consumption of East Europe is covered by imports. Out of total oil consumption of 2 million b/d in 1976, some 1.6 million b/d was supplied by imports, 85 percent of which came from the USSR. Nearly all of Eastern Europe's oil production occurs in Romania, which is almost self-sufficient, and in Yugoslavia, which now produces about 30 percent of its needs and buys the remainder for hard currency. Bulgaria, Czechoslovakia, Hungary, Poland, and East Germany are almost entirely dependent upon imports, which they now obtain almost exclusively from the USSR for soft currency.

Economic growth in Eastern Europe is slowing—only 3.5 percent in 1976 and 1977, compared with a 4.5-percent average during 1971-75—and we expect a continued slow growth—about 3.5 to 4 percent annually—during 1978-85. The growth in energy demand is also slowing. In spite of rising gas imports, renewed emphasis on coal production, and the beginning of an ambitious nuclear power program, much of the growth in energy demand will still have to be met by increased imports of oil. We expect the average annual rate of growth of oil imports to slow sharply, from 12 percent during 1971-76 to 5 percent during 1977-85. Nonetheless, Eastern Europe will need increasing quantities of imported oil.

Romania and Yugoslavia probably can afford to continue paying for most of their oil imports in hard currencies. Romania should require net imports of only about 100,000 b/d in 1985. Yugoslavia now has net imports of about 180,000 b/d, of which about one-half comes currently from the USSR, partly for hard currency. By 1985 Yugoslavia will require imports of about 250,000 b/d, with all or nearly all being obtained in hard currency markets.

The expected drop in Soviet oil production will cause serious problems for the rest of Eastern Europe. We expect that these countries will be forced to share the burden of the Soviet oil shortfall. At best there will be no increase in Soviet oil exports to Eastern Europe after 1980. At worst, these exports could cease. If by 1985 Bulgaria, Czechoslovakia, East Germany, and Hungary were forced to obtain all of their oil supplies in the West, it would cost them about $13 billion at 1977 prices. This sum is nearly equal to their total hard currency earnings last year. Clearly there is no way they could afford such large expenditures for oil. In these circumstances, the Soviets probably will continue substantial, but probably lower, exports to Eastern Europe and consequently import some OPEC oil for hard currency on their own behalf.

Other Communist Countries

The other Communist countries, except China, currently obtain most of their oil imports from the USSR. They have few energy alternatives, and their oil imports are likely to rise. Cuba accounts for the bulk of the 230,000 b/d Soviet exports to this group in 1977, and Moscow has put a very high priority on meeting Havana's energy needs in the future. Cuba consumed 180,000 b/d in 1976 and will probably use 250,000 b/d or more by 1985. In 1976 its oil imports would have cost about $900 million, or more than total Cuban hard currency earnings. As for North Korea, Vietnam, and Mongolia, their combined imports

are only about 50,000 b/d at present and are likely to rise only moderately. For them, China is a possible alternative source.

Continuing Chinese Exports

China is unlikely to become a major supplier of crude oil to the world market in the next decade. Output of 1.8 million b/d in 1977 places China among the important world producers—comparable to Indonesia and Abu Dhabi. But, domestic demand is rising rapidly, and China already consumes some 90 percent of its own production.

The growth of crude production declined from 20 percent or more a year in the early 1970s to only 8 percent in 1977. The slowdown apparently has been caused by a combination of political disorders and accelerating technical difficulties in stepping up output at larger fields. The major producing fields are now 10 or more years old, and their shallower reservoirs are nearing exhaustion. There are, however, at least four new fields with shallow reservoirs, which the Chinese can exploit with their present drilling capabilities. In the meantime Peking is importing US technology for deep drilling. It also is beginning to produce oil from the Gulf of Pohai and to drill exploratory holes on the continental shelf using rigs imported from Singapore, Japan, and Norway.

China probably will have the capability to produce more oil than the domestic economy will absorb into the early 1980s. We believe that the amount of exportable oil will level off at about 500,000 to 600,000 b/d in 1982 or so. Japan probably will take most of the exportable surplus; a recent long-term Sino-Japanese trade agreement provides for the exchange of Chinese coal and oil for Japanese technology. To increase oil exports beyond 1982, China would need considerable luck in locating large and easily exploitable reserves or would have to enforce stringent economies in domestic oil consumption.

Communist Oil Trade Balances

Depending on how soon Soviet oil production begins to decline, the rates of economic growth in the several Communist countries, and the growth of their hard currency earnings, Communist net oil imports could be as large as 2.5 million b/d in 1985 (see table 10). This figure consists of projected Chinese exports of about 500,000 b/d, imports by East European states of about 2.7 million b/d, a balanced position for the USSR, and net imports of 300,000 b/d for other Communist countries, primarily Cuba.

Table 10

Communist Countries: Net Oil Trade

Million b/d

	1976	1985
Net exporters	3.0	0.5
USSR	2.8	0
China	0.2	0.5
Net importers	−1.8	−3.0
Eastern Europe [1]	−1.6	−2.7
Other [2]	−0.2	−0.3
Balance	1.2	−2.5

[1] Including Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, Romania, and Yugoslavia.
[2] Including Albania, Cuba, Cambodia, Laos, Mongolia, North Korea, and Vietnam.

The manner in which the USSR might go about allocating oil imports and exports on its own account is, of course, a matter for speculation. Moscow currently earns a net of about $5 billion in hard currency from oil exports, primarily to West Europe. It could choose to maintain these exports, at least in part, and buy from other OPEC countries to fulfill a part of its own needs. Similarly, the USSR could continue exporting to Eastern Europe while importing compensating quantities from OPEC. Since OPEC countries are unlikely to sell very large quantities for anything other than hard currency, the net effect of such arrangements on the Soviet hard currency balance of payments would, at a minimum, be similar to cessation of Soviet exports of oil. To the extent that the USSR imports oil for hard currency so that it can continue exports to Eastern Europe or Cuba for soft currency, the hard currency balance of payments would worsen still further.

The Communist countries probably would be able to finance net imports of the projected

magnitude if the real price of oil remained near present levels. The total hard currency imports and hard currency receipts of the USSR, Eastern Europe, and Cuba as a group were roughly in balance in 1977; they amounted to about $33 billion on both sides of the ledger. These countries' net hard currency oil exports were about $5 billion in 1977; the projected net oil imports for hard currency of about 2.5 million b/d in 1985 [13] would cost at least $12 billion at 1977 prices. The resulting shift on the oil account of some $17 billion consequently is about one-half of current hard currency receipts. It is reasonable to expect that foreign currency receipts from nonoil exports, gold, and net credits will increase by at least $10 billion through 1985. Consequently, although some cuts in nonoil imports would be necessary, it seems likely that all high-priority imports could be accommodated.

[13] Excluding projected oil imports through barter deals of about 400,000 b/d and projected Chinese exports.

This projection assumes Soviet oil production in 1985 is 10 million b/d, the upper end of the range we consider likely. If production were at the lower end of our projection—that is, 8 million b/d—we doubt that the shortfall could be made up through additional oil imports for hard currency. Imports of the necessary magnitude would place an intolerable burden on the combined balance of payments of the Soviet Union and Eastern Europe. We consequently believe that any added shortfall in Soviet oil supply will be absorbed by the Soviet and East European economies through slower economic growth rather than be reflected on the world oil market. [14] Although the future volume of Communist oil imports is extremely uncertain, we have no doubt that the USSR and Eastern Europe face very difficult energy problems and painful policy choices.

[14] The figure of 3.5 million to 4.5 million b/d used in our April 1977 report was based on slightly faster Soviet economic growth projections and made no allowance for conservation or balance-of-payments constraints.

VI. WORLD DEMAND FOR OPEC OIL THROUGH 1985

On the basis of the various projections described above, we project that world demand for OPEC oil could mount to 41.6 million to 45.0 million b/d, assuming that adequate oil supplies existed to support these levels of demand (see table 11). The lower demand would be consistent with a 3.7-percent average annual rate of growth in the OECD in 1978-85. The other end of the demand range reflects a 4.2-percent annual growth rate in the developed countries. Both scenarios take account of an approximate doubling in OPEC demand for its own oil between 1977 and 1985, to 4 million b/d.

Oil Supply and Demand Balances: Implications

Although the range of uncertainty surrounding energy supply and demand is great, it is clear that the supply of oil in key OPEC and non-OPEC countries in the first half of the 1980s will not leave much margin to support potential demand other than in the most favorable circumstances. This does not necessarily mean that oil prices will

Table 11

World Demand for OPEC Oil

Million b/d Oil Equivalent

			Projected		
		1977 [1]	1980	1982	1985
	OECD [2] total energy demand:				
	3.7 percent OECD growth in real GNP, 1978-85 [3]	75.4	82.6	87.4	94.6
	4.2 percent OECD growth in real GNP, 1978-85 [3]	75.4	83.4	89.3	98.0
Minus:	OECD energy production	47.4	53.2	55.5	59.4
	OECD net nonoil energy imports	1.7	2.7	3.1	3.7
Plus:	Oil requirements for strategic storage		0.8 [4]		
	Statistical discrepancy	0.5			
Equals:	OECD net oil import demand:				
	3.7 percent OECD growth in real GNP, 1978-85	26.8	27.5	28.8	31.5
	4.2 percent OECD growth in real GNP, 1978-85	26.8	28.3	30.7	34.9
Plus:	Net oil import demand of:				
	Other developed countries [5]	0.7	0.9	1.0	1.3
	Non-OPEC LDCs	3.0	2.1	2.2	2.3
	OPEC oil demand	2.3	3.0	3.4	4.0
Minus:	Net exports of Communist countries	1.1	0.4	−0.6	−2.5
Equals:	Required OPEC production: [6]				
	3.7 percent OECD growth in real GNP, 1978-85	31.7	33.1	36.0	41.6
	4.2 percent OECD growth in real GNP, 1978-85	31.7	33.9	37.9	45.0

[1] Estimated.
[2] Excluding Australia and New Zealand.
[3] The scenarios imply constant OECD unemployment assuming the historic relationship between employment and GNP growth (OECD average 4.2 percent) or, alternatively, constant unemployment assuming a decline in the historic relationship of productivity to GNP growth (OECD average 3.7 percent).
[4] Including additions to strategic oil reserves of 600,000 b/d for the United States and 100,000 b/d each for Japan and Western Europe.
[5] Including Australia, Israel, New Zealand, and South Africa.
[6] Including natural gas liquids.

rise greatly, even though the risk of this development is high. If economic growth is low enough to avoid a substantial price hike, unemployment in the developed countries will probably rise instead.

The chance of oil stringencies mounts as 1985 approaches (see figure 12). The risk of demand catching up with supply by 1982 is relatively low, except at high rates of economic growth. Economic growth clearly high enough to reduce unemployment in the OECD (above 4.2 percent annually) would bring on oil market strains in 1982 under all our supply assumptions. In 1983-84 only a Saudi commitment to push output to 12.5 million b/d and simultaneously optimistic developments in other OPEC producers along with economic growth rates under 3.5 percent annually stave off an oil market problem. By 1985 all combinations of our baseline demand and supply scenarios become untenable. Our forecast of Communist country net oil imports is not critical to the overall conclusion about the risks of oil market stringencies. If the Communist countries were able to avoid any net oil imports, however, the projected arrival of demand pressure on oil supplies would be postponed for about one year for each combination of OPEC supply and OECD demand.

To test the sensitivity of these results to alternative conservation and nonoil energy supply developments, we deflated our baseline OECD energy demand scenarios by an additional 2.5 percent, 5 percent, and 10 percent in 1985 (rising linearly through 1978-85).[18] The first cut amply allows for the impact of the 2-million b/d reduction in US oil import demand that the Department of Energy estimates is possible as a result of currently proposed US legislation or for programs with equivalent impact throughout the rest of the OECD. The second allows for both. The third cut allows for large error in projecting energy and oil demand. At the extreme 10-percent case, these reductions take 10 million to 10.7 million b/d off net OECD oil import demand in 1985, reducing world demand for OPEC oil to only 31.6 million to 34.3 million b/d across the span of GNP assumptions.

Allowing for the 2.5-percent reduction shifts the period of high risk of an oil problem by about a year, to 1983-85. In fact, under this alternative conservation assumption, a combination of low economic growth and high OPEC supply would postpone the emergence of oil market stringencies to 1986. The 5-percent reduction buys even more time, even though by 1985 oil demand pressures approach within 1 million b/d of oil supplies under all combinations of our scenarios except a combination of high OPEC production and low OECD growth. The 10-percent reduction gets the world through 1985 without an oil problem unless OPEC production is at the low end of our range and growth at the high end.

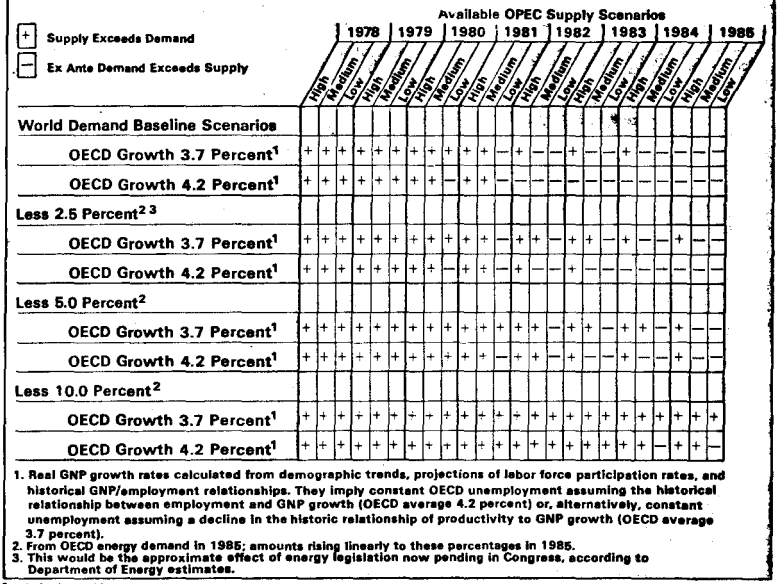
A number of circumstances could reduce the risk of an oil problem in the first half of the 1980s. Specifically:

- OECD GNP growth would have to average substantially less than 3.7 percent annually in 1978-85; *or*
- Kuwait and Abu Dhabi would have to lift current production restrictions, Saudi Arabia would have to eliminate numerous operating constraints and shortly make hefty new investments, Iran's gas-reinjection program would have to succeed, and Iraq would have to reach the high side of the range we forecast; *or*
- Oil-consuming countries would have to adopt major new incentives to induce increased investment in energy-saving equipment, more rapid turnover of the automobile stock, and increased nonoil energy development

[18] Independent errors in projecting energy supplies and demands tend to cancel, without having much effect on the probability of an OPEC supply shortfall. To assess the cancellation of errors, we computed the probability of an OPEC supply shortfall in 1985, given five conditions: (a) the OPEC supply and demand gap depends on 11 different variables, namely the OECD energy demand and the OECD production of oil and nonoil energy sources; and oil supplies and demands in other developed countries, the non-OPEC LDCs, the Communist countries, and OPEC; (b) the best guess for each of the 11 variables is our midrange estimate; (c) each estimate is subject to error; (d) the error term for each estimate is a normally-distributed random variable with a zero mean and a standard deviation equal to 10 percent of the estimate; and (e) the 11 error terms are independent. Even with such generous allowances for estimative errors, there is a 74-percent chance of an OPEC supply shortfall in 1985.

Figure 12

Supply of and Demand for OPEC Oil



1. Real GNP growth rates calculated from demographic trends, projections of labor force participation rates, and historical GNP/employment relationships. They imply constant OECD unemployment assuming the historical relationship between employment and GNP growth (OECD average 4.2 percent) or, alternatively, constant unemployment assuming a decline in the historic relationship of productivity to GNP growth (OECD average 3.7 percent).
2. From OECD energy demand in 1985; amounts rising linearly to these percentages in 1985.
3. This would be the approximate effect of energy legislation now pending in Congress, according to Department of Energy estimates.

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and consumption. These savings would have to lead to a decline in the relationship of energy use to GNP at least as rapid as the 1.5-percent annual reduction that took place during 1974-76; *or*

- Some combination of relatively slow economic growth, larger energy savings than most observers expect, and expansive OPEC oil policies would have to occur.

Counterpressures

Political and social pressures in the oil-consuming countries in many cases appear to be at cross-purposes with developments that would reduce potential oil market stringencies. For instance, with unemployment at more than 16 million almost three years after the trough of the last recession, OECD governments are under severe pressure to stimulate economic growth. A cluster of national elections scheduled in 1980 and 1981 will reinforce the temptation to reflate. While the threshold of public tolerance for unemployment is uncertain, it is doubtful whether many electorates would easily accept the reality of fewer jobs in the short run to avoid a dimly perceived oil-induced economic slowdown in the mid-1980s.

Meanwhile, the glut on the oil market due to new flows of North Sea and Alaskan oil at a time

of relatively sluggish demand and the overcapacity in coal industry due in part to slumping world steel demand undermine public—and even in some cases governmental—recognition of the oil constraint. This delays the adoption of better energy policies as well as changes in lifestyles. In many countries, the sluggish pace of investment also acts against substantial conservation gains by postponing the introduction of more energy-efficient production methods and machines.

Impact of a Possible Price Rise

If government policies in the developed countries lead to demand stimulation in the face of a slowdown in oil supply growth, a major increase in real prices of oil—and eventually other forms of energy—is likely. The burden of adjustment to higher prices in the short run will fall mostly on economic growth. Higher real energy prices would act to reduce GNP growth and increase unemployment in several ways.

- Rising energy prices would transfer income from energy users to producers who probably would not immediately spend their new financial surplus. The resulting drop in income in each country would be self-reinforcing because countries depend on the imports of others to buoy economic growth.
- Higher oil prices would restrict the availability of a factor of production (oil), reducing the productive potential of the world economy. Hence, even if governments tried to offset the demand-reducing effects of higher oil prices, GNP still would be lower and inflation higher than if oil supplies were growing more rapidly.
- Some governments would pursue contractionary economic policies to alleviate foreign payments deficits and inflation triggered by higher energy prices. Although policymakers are aware that such behavior worsened the economic downturn following the 1973-74 price hikes, their reactions today probably would not be much different, particularly since many industrial countries now have large external debts. In any event, in a very tight oil market, attempts to offset the impact on GNP of a price rise could pave the way to another increase in prices.

Following the 1973/74 oil price increases, the developed world was plagued by the deepest recession in the postwar period. Growth losses in most industrial countries were coupled with double-digit inflation and rapidly deteriorating international trade positions. Between 1973 and 1975, growth of OECD GNP was cut by almost 8 percent, while consumer prices rose well over 30 percent. While the quadrupling in oil prices following the oil embargo was not the only factor at work, its impact contributed greatly to the subsequent dismal economic performance. We calculate that a 10-percent increase in real crude oil prices today would shave about one-half a percentage point off OECD economic growth and add slightly more than that to the rate of inflation. Such a price hike now is roughly comparable in size to a 60-percent increase in OPEC prices around the time of the embargo because oil now has a much greater weight in economic activity, particularly in the cost structure of firms.

OPEC Pricing Decisions

As indicated earlier, our basic analysis assumes:

- Real prices for final energy remain constant in Western Europe, Japan, and Canada in 1977-85.
- Real prices for final energy in the United States rise 2.5 percent annually in 1977-85.
- Real prices for OPEC oil exports remain constant in 1979-85.

In our projections, the demand for OPEC oil is determined in part by real final energy prices and in part by real GNP. Real final energy prices are, in turn, determined in part by the real price of OPEC oil. Real OPEC oil prices have declined since 1976; the scant information available indicates, however, that final energy prices in the consuming countries held constant or even rose because of increases in taxes on energy products and in nonoil energy prices. Thus, our assumption of constant real prices for final energy in the industrial countries during a period of falling real

Table 12

OPEC: Current Account Balance

Billion US $

	1974	1977	1978 [1]
Total	73.1	33.8	16.9
Algeria	1.2	−3.2	−3.4
Ecuador	0.3	−0.8	−0.7
Gabon	0.1	−0.1	−0.3
Indonesia	1.5	1.3	0.5
Iran	13.2	5.8	3.7
Iraq	3.5	3.5	2.5
Kuwait	7.1	4.4	5.3
Libya	2.5	3.3	2.5
Nigeria	5.5	−1.0	−2.7
Qatar	1.4	0.8	0.8
Saudi Arabia	24.9	15.4	8.0
UAE	5.7	4.7	3.7
Venezuela	6.2	−0.3	−3.0

[1] Estimated.

prices for OPEC oil appears reasonable. Consequently, a nominal increase in the price of OPEC oil adequate to restore purchasing power per barrel of oil exported to 1976 levels would lead to an increase in real energy prices in the consuming countries, unless the latter lowered taxes or took other compensating action.

Considerable pressure exists within OPEC to obtain an increase in the real price of oil. The overall OPEC current account surplus is shrinking (see table 12). OPEC members realize that relative oil prices dropped in 1976-78 because of a) small or no increases in nominal oil prices, (b) rising export prices on the part of major OPEC suppliers, and (c) recent dollar depreciation. In 1978 we estimate that the average real price of OPEC oil will be down by 8 percent from the average price in 1976; at the same time, a number of OPEC countries—notably Nigeria, Ecuador, Algeria, and Venezuela—badly need additional revenues to pay for the imports to fulfill ambitious development plans.

OPEC could, therefore, decide to raise oil prices even in the face of the slack oil market. The cartel could support higher prices through shared production cutbacks and still increase its revenues. If OPEC decided to increase the price of oil at a faster rate than that of overall world inflation, the rise in real oil prices would induce additional conservation. If governments did not offset the impact on GNP of rising energy costs, a rise in real OPEC oil prices also would cut oil demand by slowing world economic growth. The reductions in demand would postpone the emergence of severe market pressures, and the oil constraint on economic growth might never overtly manifest itself. One cost, of course, would likely be substantially higher unemployment than would otherwise be the case in the next several years.

Anticipation of a coming oil crunch also could lead to increases in real OPEC oil prices in the next several years. If OPEC perceives an upcoming tight market, it might decide to stagger price hikes ahead of time to graduate the impact on the world economy. A series of moderate, anticipatory real increases would have a gradual but cumulative deflationary impact on economic activity. Alternatively, if world awareness of the impending problem spreads, speculative pressures alone might act to force up prices in the next few years. In the event that OPEC real oil prices hold steady into the early 1980s, a rather sudden steep runup in oil prices could occur as demand began to overtake available oil supplies.

Concluding Note

Whatever precise path the oil constraint takes, most countries face a difficult transition period to societies less dependent on oil. Policy options in the short run are to a considerable extent limited by construction leadtimes, the capital stock, and even court decrees and lifestyles. Policies that could act to reduce oil demand will likely conflict with policies aimed at full employment and reduced inflation as well as with environmental concerns. With the social, political, and economic tradeoffs apt to be harsh, the decisions that policymakers will be called on to make in the next several years will carry new dimensions of risk.

Many persons in the Office of Economic Research have contributed to this paper. Comments and queries are welcome and should be directed to the International Energy Branch, 351-5804.

APPENDIX A

METHODOLOGY

OECD Energy Data Base

In constructing energy demand series for the United States, Japan, Western Europe, and Canada, we used primary data sources whenever possible. In most cases the primary data are reported in original energy units, which we converted to a common unit—million b/d oil equivalent (see table A-1). The unit conversion to million barrels per day allows oil demand—the largest component of US energy demand—to be measured without conversion.

Our data on energy demand differ from comparable data compiled by other researchers. These differences are as follows, in decreasing order of importance:

- Our demand series are aggregations of total production and trade data for individual fuels, rather than aggregations of data on final energy use by individual energy-consuming sectors.

Table A-1

OECD:[1] Energy Demand

Million b/d Oil Equivalent

	United States	Japan	Western Europe	Canada
1960	21.32	1.76	12.49	1.84
1961	21.82	2.09	12.96	1.89
1962	22.81	2.24	13.89	1.98
1963	23.85	2.48	14.87	2.16
1964	24.88	2.74	15.82	2.38
1965	25.95	2.99	16.57	2.59
1966	27.46	3.35	17.26	2.64
1967	28.80	3.74	17.70	2.80
1968	30.11	4.26	18.73	2.98
1969	31.67	4.88	19.79	3.18
1970	33.35	5.66	21.57	3.43
1971	33.88	5.97	22.43	3.54
1972	35.47	6.34	23.16	3.92
1973	36.89	6.98	24.63	4.17
1974	36.05	6.99	24.38	4.27
1975	35.45	6.62	23.31	4.28
1976	36.86	6.85	24.84	4.34

[1] Excluding Australia and New Zealand.

- We do not exclude marine bunkers in estimating oil consumption.
- Our estimates of US oil consumption do not include processing (or refinery) gains.
- We use an average heat rate for thermal power plants to measure electricity production from hydro, nuclear, and geothermal sources (in million b/d oil equivalent).
- We use Canadian natural gas data that conform to the US definition of marketable gas production.
- We rely on primary data sources to eliminate the unexplained or incomplete data revisions apparent in some published time series of data on energy demand.
- We use Japanese energy data defined on the basis of calendar years rather than fiscal years.
- We report gross rather than net primary electricity production.
- We use different conversion factors for different fuels and countries to convert energy demands into million b/d oil equivalent.

To estimate relative prices of energy for the United States, Japan, Western Europe, and Canada, we developed an end-use energy price series for each of the four regions. We then converted the series to constant dollars, using GNP deflators. The end-use price series are weighted averages of prices for major energy classes—solid fuels, petroleum production, natural gas, and electricity. The weights are shares of total energy consumption. The prices for the major energy classes are weighted averages of prices paid by classes of energy consumers (see table A-2).

Other studies have estimated higher short-run and long-run price elasticities for energy demand than we have obtained in our research. * Our analysis of the possible causes of these differences indicates that one major source of discrepancies is the choice of historical time periods used as the basis for estimates. Most other estimates were made against estimation periods ending in 1973 or earlier, while our estimates incorporate 1974-76 data. The time period chosen does make a substantial difference in the results obtained. For example, our estimates of the US short-run and long-run energy demand price elasticities, using 1961-76 data, were -0.075 and -0.20, respectively. In contrast, using the identical equation but estimating over 1961-73 yields short-run and long-run price elasticities of -0.095 and -0.268; estimating over 1961-72 yields short-run and long-run elasticities of -0.11 and -0.334.

*For example, see William D. Nordhaus, *The Demand for Energy: An International Perspective*, Cowles Foundation Discussion Paper No. 405, 1975; and Michael Kennedy, "An Economic Model of the World Oil Market, *The Bell Journal of Economic and Management Science*, Autumn 1974.

Table A-2

OECD:[1] Relative Prices of Energy[2]

Index: 1970 = 100

	United States	Japan	Western Europe	Canada
1960	123.6	165.0	128.7	124.3
1961	122.5	153.9	127.9	122.2
1962	119.1	149.6	126.6	120.8
1963	117.3	145.1	123.7	118.4
1964	115.5	137.1	119.0	114.4
1965	113.1	134.5	115.0	110.9
1966	110.7	126.4	109.6	108.4
1967	108.5	119.5	110.4	105.3
1968	104.7	113.3	109.7	104.1
1969	100.4	105.2	105.2	101.5
1970	100.0	100.0	100.0	100.0
1971	101.2	100.7	102.7	101.1
1972	98.9	92.2	99.2	96.7
1973	103.0	91.1	95.6	96.7
1974	129.3	123.5	107.1	105.3
1975	134.5	141.4	123.1	106.4
1976	138.4	143.2	124.6	116.8

[1] Excluding Australia and New Zealand.
[2] Ratio of the index of aggregate relative price of energy to the GDP deflator.

OECD Energy Demand Projections

We follow four steps in projecting annual OECD energy demand through 1985:

- We assume future scenarios for real GNP and energy prices. We consider two alternative GNP scenarios. Historical data on GNP growth rates appear in table A-3, and the two future scenarios appear in tables A-4 and A-5. Regarding relative prices of energy, we assume US energy prices will increase in real terms by 2.5 percent annually, beginning in 1977. Real energy prices elsewhere are assumed to remain constant. The scenarios for GNP and energy prices are not forecasts. Rather, the scenarios are used to estimate when market forces may begin to drive up OPEC oil prices.
- We estimate energy demand equations for the United States, Japan, Western Europe, and Canada. Details of the equations are explained below. In using the equations to project energy demand, we allow for the effects of assumed trends in energy prices and overall economic activity; but we initially omit the future demand impacts of the US Energy Policy and Conservation Act (EPCA) and other national energy policies that do not rely entirely on changes in energy prices.
- To allow for the future effects of the EPCA and other nonprice influences on energy demands, we then decrement the forecasts

Table A-3

OECD:[1] Historical Real GNP Growth Rates

Percent

	United States	Japan	Western Europe	Canada
1961	2.3	14.6	5.8	3.1
1962	5.6	7.1	4.4	6.8
1963	4.1	10.5	4.5	5.5
1964	5.1	13.2	6.0	6.4
1965	6.0	5.1	4.2	6.8
1966	6.0	9.8	4.1	7.0
1967	2.7	12.9	3.0	3.4
1968	4.5	13.5	5.3	5.6
1969	2.6	10.7	6.1	5.2
1970	−0.1	10.9	5.4	2.6
1971	2.9	7.3	3.5	6.6
1972	5.8	8.9	3.9	5.6
1973	5.4	9.8	5.2	7.2
1974	−1.6	−1.1	2.0	3.2
1975	−1.3	2.4	−1.3	1.1
1976	6.0	6.3	4.2	4.9

[1] Excluding Australia and New Zealand.

Table A-4

OECD:[1] 3.7-Percent Growth Scenario

Percent

	United States	Japan	Western Europe	Canada
1977	4.8	5.7	2.0	2.0
1978	4 ¼	5 ¼	2 ¾	3 ¾
1979	4.0	6.0	3 ¼	4.0
1980	4.0	6.0	3 ¼	4.0
1981	4.0	6.0	3 ¼	4.0
1982	2 ¾	6.0	3 ¾	2 ½
1983	2 ¾	6.0	3 ¾	2 ½
1984	2 ¾	6.0	3 ¾	2 ½
1985	2 ¾	6.0	3 ¾	2 ½

[1] Excluding Australia and New Zealand.

Table A-5

OECD:[1] 4.2-Percent Growth Scenario

Percent

	United States	Japan	Western Europe	Canada
1977	4.8	5.7	2.0	2.0
1978	4 ¼	5 ¼	2 ¾	3 ¾
1979	4 ½	6 ½	3 ¾	4 ½
1980	4 ½	6 ½	3 ¾	4 ½
1981	4 ½	6 ½	3 ¾	4 ½
1982	3 ¼	6 ½	4 ¼	3.0
1983	3 ¼	6 ½	4 ¼	3.0
1984	3 ¼	6 ½	4 ¼	3.0
1985	3 ¼	6 ½	4 ¼	3.0

[1] Excluding Australia and New Zealand.

obtained from the demand equations. The percentage decrement increases linearly from zero in 1977 to 5 percent in 1985. This decremented estimate is the CIA baseline forecast for OECD energy demand.

- Given the demand forecasts adjusted for the EPCA and other non-price conservation measures, we add to each annual forecast an allowance for the oil demand necessary to meet government plans for emergency

Table A-6

OECD: [1] Projection of Energy Demand

Million b/d Oil Equivalent

	1977	1978 [2]	1979 [2]	1980 [2]	1981	1982	1983	1984	1985
Total									
3.7 percent growth scenario [3]	75.4	78.1	80.6	83.4	85.2	87.4	89.8	92.1	94.6
4.2 percent growth scenario [3]	75.4	78.1	80.9	84.2	86.6	89.3	92.0	95.1	98.0
United States									
3.7 percent growth scenario [3]	38.6	40.2	41.4	42.9	43.6	44.4	45.2	46.0	46.9
4.2 percent growth scenario [3]	38.6	40.2	41.6	43.3	44.3	45.4	46.4	47.5	48.6
Canada									
3.7 percent growth scenario [3]	4.5	4.6	4.8	5.0	5.2	5.3	5.4	5.5	5.6
4.2 percent growth scenario [3]	4.5	4.6	4.8	5.0	5.3	5.4	5.5	5.7	5.8
Western Europe									
3.7 percent growth scenario [3]	25.1	25.7	26.4	27.1	27.7	28.6	29.6	30.5	31.5
4.2 percent growth scenario [3]	25.1	25.7	26.5	27.4	28.2	29.2	30.3	31.5	32.6
Japan									
3.7 percent growth scenario [3]	7.2	7.6	8.0	8.4	8.7	9.1	9.6	10.1	10.6
4.2 percent growth scenario [3]	7.2	7.6	8.0	8.5	8.8	9.3	9.8	10.4	11.0

[1] Excluding Australia and New Zealand.

[2] Assuming additions to strategic oil reserves for the United States of 400,000 b/d in both 1978 and 1979, and 600,000 b/d in 1980; 100,000 b/d each for Japan and Western Europe in 1978-80.

[3] The scenarios imply constant OECD unemployment assuming the historic relationship between employment and GNP growth (OECD average 4.2 percent) or, alternatively, constant unemployment assuming a decline in the historic relationship of productivity to GNP growth (OECD average 3.7 percent).

Table A-7

OECD: [1] Energy Demand Equation Parameter Estimates

	Constant Term (Denoted A0)	Real GNP Elasticity (A1)	First-Year Price Elasticity (B)	Long-Run Price Elasticity (B/(1-L))
United States	2.21065	1.10000	−0.07305	−0.20716
Japan	3.20094	0.95803	−0.15679	−0.26577
Western Europe	6.12451	1.03385	−0.19777	−0.19777
Canada	4.05259	1.10625	−0.25709	−0.27084

[1] Excluding Australia and New Zealand.

reserves. These allowances and our projections of final energy demand appear in table A-6.

Our energy demand equations are based primarily on two assumptions:

- Should energy prices remain constant in any of the four regions for which we estimate energy demands, then percentage changes in the region's GNP lead to roughly proportionate percentage changes in the region's demand for energy. The proportionality factor—often called the elasticity of energy demand with respect to GNP—varies from region to region.

- A small percentage change in a region's energy prices in any year lead to a proportionate reduction in the region's energy demand that year. The proportionality factor for the first year is known as the region's short-run price elasticity of energy demand. Moreover, an energy price increase in any year decreases energy demands in subsequent years. The total demand effect of a price increase is measured by a long-run price elasticity.

In mathematical terms we assume that a region's total energy demand in any year, denoted ED(t), depends on the region's real gross national product GNP(t), and on current and past energy prices P(t), P(t-1), P(t-2), ... As well the energy demand ED(t) depends on several parameter estimates, namely a constant term A0, an energy demand/GNP elasticity A1, and price elasticities B0, B1, B2, ..., corresponding to the price variables P(t), P(t-1), P(t-2), . . . The price elasticities presumably decline geometrically over time. In particular, we use a term L to denote a value between zero and one and a term B to denote a negative parameter estimate, such that B0 is the product of B times 1 raised to the power zero; and B1 = (B) (L^1), B2 = (B) (L^2), and so on. Thus the natural logarithm of energy demand (lnED(t)) can be written as:

$$lnED(t) = lnA0 + A1 lnGNP(t) + BL^0 lnP(t) + BL^1 lnP(t-1) + BL^2 lnP(t-2) + \ldots.$$

Thus:

$$(L)lnED(t-1) = (L)lnA0 + (L)\,(A1 lnGNP(t-1)) + BL lnP(t-1) + BL^2 lnP(t-2) + BL^3 lnP(t-3) + \ldots.$$

Taking the difference between these two equations and then rearranging terms, we derive the general form for our energy demand equations:

$$lnED(t) = (1-L)lnA0 + A1 lnGNP(t) - (L)\,(A1 lnGNP(t-1)) + B lnP(t) + (L)lnED(t-1).$$

Our estimates of the demand equation parameters appear in table A-7. Had we used these estimates to predict energy demands in the past, our forecasts would have been accurate within +4 percent for each of the four OECD regions and within +3 percent for the OECD countries as a whole (see tables A-8 through A-12).

Alternative OECD Energy Demand Projections

Slight variations in the demand equation parameters can lead to large differences in energy demand forecasts. The US demand equation is a case in point. Our estimate of the US energy/GNP elasticity is 1.1. Changing this to 1.0 and slightly increasing the long-run and short-run price elasticities—that is, reducing the assumed role of GNP and increasing that of price in determining demand—results in a revised demand equation with slightly improved overall

Table A-8

OECD:[1] Historical Test of the Energy Demand Equation

	Energy Demand (Million b/d Oil Equivalent)		Forecast Error (Percent of Actual Demand)
	Actual	Predicted	
1962	40.9	40.8	−0.35
1963	43.4	42.8	−1.29
1964	45.8	45.6	−0.40
1965	48.1	48.4	0.71
1966	50.7	51.7	1.86
1967	53.0	53.7	1.19
1968	56.1	57.0	1.61
1969	59.5	60.1	1.04
1970	64.1	62.3	−2.73
1971	65.8	64.7	−1.78
1972	68.9	68.8	−0.14
1973	72.7	73.3	0.80
1974	71.8	71.6	−0.15
1975	69.7	69.5	−0.21
1976	72.8	72.8	−0.15
Average percent error			−0.00921
Root mean square percent error			1.181

[1] Excluding Australia and New Zealand.

Table A-9

United States: Historical Test of the Energy Demand Equation

	Energy Demand (Million b/d Oil Equivalent)		Forecast Error (Percent of Actual Demand)
	Actual	Predicted	
1962	22.8	22.6	−0.73
1963	23.8	23.6	−1.16
1964	24.9	24.9	−0.10
1965	26.0	26.5	2.15
1966	27.5	28.3	3.13
1967	28.8	29.2	1.54
1968	30.1	30.8	2.36
1969	31.7	31.9	0.71
1970	33.4	32.0	−4.09
1971	33.9	33.1	−2.40
1972	35.5	35.3	−0.51
1973	36.9	37.3	1.25
1974	36.1	36.1	0.01
1975	35.5	35.0	−1.14
1976	36.9	36.9	0.24
Average percent error			0.083
Root mean square percent error			1.883

Table A-10

Japan: Historical Test of the Energy Demand Equation

	Energy Demand (Million b/d Oil Equivalent)		Forecast Error (Percent of Actual Demand)
	Actual	Predicted	
1962	2.2	2.2	0.26
1963	2.5	2.5	0.37
1964	2.7	2.8	3.53
1965	3.0	3.0	0.30
1966	3.4	3.3	−0.82
1967	3.7	3.8	1.21
1968	4.3	4.3	1.75
1969	4.9	4.9	−0.37
1970	5.7	5.5	−3.69
1971	6.0	5.9	−1.83
1972	6.3	6.5	1.91
1973	7.0	7.1	2.09
1974	7.0	6.7	−3.50
1975	6.6	6.6	0.22
1976	6.8	6.9	0.84
Average percent error			0.081
Root mean square percent error			1.919

Table A-11

Western Europe: Historical Test of the Energy Demand Equation

	Energy Demand (Million b/d Oil Equivalent)		Forecast Error (Percent of Actual Demand)
	Actual	Predicted	
1962	13.9	14.9	−0.01
1963	14.9	14.6	−1.81
1964	15.8	15.6	−1.21
1965	16.6	16.4	−0.92
1966	17.3	17.3	0.10
1967	17.7	17.8	0.49
1968	18.7	18.8	0.30
1969	19.8	20.1	1.77
1970	21.6	21.5	−0.42
1971	22.4	22.1	−1.30
1972	23.2	23.2	0.12
1973	24.6	24.6	−0.05
1974	24.4	24.6	0.77
1975	23.3	23.6	1.16
1976	24.8	24.5	−1.18
Average percent error			−0.146
Root mean square percent error			0.975

Table A-12

Canada: Historical Test of the Energy Demand Equation

	Energy Demand (Million b/d Oil Equivalent)		Forecast Error (Percent of Actual Demand)
	Actual	Predicted	
1962	2.0	2.0	1.79
1963	2.2	2.1	−0.54
1964	2.4	2.3	−2.49
1965	2.6	2.5	−2.75
1966	2.6	2.7	3.47
1967	2.8	2.9	2.01
1968	3.0	3.0	2.15
1969	3.2	3.2	1.94
1970	3.4	3.3	−2.37
1971	3.5	3.6	1.26
1972	3.9	3.9	−1.76
1973	4.2	4.2	−0.22
1974	4.3	4.2	−1.28
1975	4.3	4.3	−0.69
1976	4.3	4.4	0.79
Average percent error			0.088
Root mean square percent error			1.904

performance in historical tests over the 15-year period 1962-76. The improvement appears, however, primarily in the 1960s—a period of steadily falling energy prices—and especially in the early part of the decade, when economic structure and technology are least similar to the current situation. During the 1974-76 period—when the effects of a dramatic 1973/74 oil price increase and gradual further increases were being experienced—the revised equation is less accurate in predicting energy demand than the one we have chosen. Moreover, on the basis of only three years' experience, the revised equation appears to have a persistent downward bias, while the equation we have chosen seems to bracket actual results (see table A-13).

Non-OECD, Non-Communist Projections

We estimated the historical relationship between economic activity as measured by GDP and oil consumption for 10 large oil-consuming less developed countries individually; for Australia, Israel, New Zealand, and South Africa; and for the remaining non-OPEC LDCs as a group (see table A-14). The oil/GDP elasticities for each of these groups were calculated primarily from 1960-73 data. Oil consumption was projected beginning in 1977 on the basis of the historical elasticities and assumptions about future levels of GDP growth. In most cases, these growth rates approximate four-fifths of their historical levels. For Mexico, we used Pemex estimates of oil consumption.

Table A-13

United States: Historical Comparison of Alternative Energy Demand Equations

	Energy Demand (Million b/d Oil Equivalent)			Forecast Error (Percent of Actual Demand)	
	Actual	Prediction One [1]	Prediction Two [2]	Prediction One	Prediction Two
1961	21.8	21.5	21.7	−1.42	−0.42
1962	22.8	22.6	22.9	−0.73	0.49
1963	23.8	23.6	23.9	−1.16	0.14
1964	24.9	24.9	25.1	−0.10	1.04
1965	26.0	26.5	26.7	2.15	2.96
1966	27.5	28.3	28.4	3.13	3.55
1967	28.8	29.2	29.3	1.54	1.85
1968	30.1	30.8	30.8	2.36	2.41
1969	31.7	31.9	31.9	0.71	0.69
1970	33.4	32.0	32.1	−4.09	−3.88
1971	33.9	33.1	33.1	−2.40	−2.25
1972	35.5	35.3	35.2	−0.51	−0.72
1973	36.9	37.3	37.1	1.25	0.67
1974	36.1	36.1	35.9	0.01	−0.33
1975	35.5	35.0	34.9	−1.14	−1.51
1976	36.9	36.9	36.5	0.24	−1.02
1977		38.6	37.7		
1978		40.2	39.1		
1979		41.6	40.1		
1980		43.3	41.4		
1981		44.3	42.0		
1982		45.4	42.7		
1983		46.4	43.4		
1984		47.5	44.1		
1985		48.6	44.8		

[1] Based on a US real GNP growth rate of 3.8 percent for 1978-85—the US figure in the OECD 4.2 percent growth scenario.

[2] Based on a US real GNP growth rate of 3.8 percent for 1978-85, with three exceptions—(a) the energy demand/GNP elasticity is assumed to be 1.0 rather than 1.1 as in Prediction One, (b) the short-term price elasticity is −0.075 rather than −0.073, and (c) the long-term price elasticity is −0.33 rather than −0.21.

Table A-14

Non-OECD Free World Countries:
Estimated Income Elasticities and Real GDP Growth

	Income Elasticities	Estimative Period	Real GDP Growth During 1978-85 [1] (Percent)
Non-OPEC LDCs			
Argentina	1.30	1960-73	3
Brazil	1.17	1960-73	6
Colombia	1.36	1969-73	4
Peru	1.25	1960-73	4
Egypt	1.70	1964-68	3
India	1.50	1960-73	4
Philippines	1.73	1960-73	4
South Korea	1.14	1970-74	8
Taiwan	1.62	1960-73	8
Thailand	2.13	1960-73	4
Other Developed Countries			
Australia	1.56	1960-73	4
Israel	0.91	1960-73	3
New Zealand	1.79	1960-73	3
South Africa	1.00	1960-73	5

[1] Average annual rate.

APPENDIX B

SUPPLEMENTAL STATISTICAL TABLES

Table B-1

OPEC: High Oil Production Scenario [1]

Million b/d

	1977	Projected 1980	1982	1985
Total	**31.7**	**36.7**	**37.5**	**40.1**
Algeria	1.1	1.3	1.3	1.4
Ecuador	0.2	0.2	0.2	0.3
Gabon	0.2	0.2	0.2	0.2
Indonesia	1.7	1.7	1.7	1.7
Iran	5.7	6.2	6.1	6.0
Iraq	2.3	3.1	3.5	4.0
Kuwait	2.0	3.3	3.3	3.3
Libya	2.1	2.5	2.5	2.5
Nigeria	2.1	2.3	2.3	2.5
Qatar	0.5	0.6	0.5	0.5
Saudi Arabia	9.4	10.5	11.3	12.5
UAE	2.0	2.4	2.6	2.9
Abu Dhabi	1.7	2.0	2.2	2.5
Dubai	0.3	0.3	0.3	0.3
Sharjah	Negl	0.1	0.1	0.1
Venezuela	2.3	2.4	2.3	2.3

[1] Including natural gas liquids.

Table B-2

OPEC: Medium Oil Production Scenario [1]

Million b/d

	1977	Projected 1980	1982	1985
Total	**31.7**	**34.4**	**35.6**	**36.4**
Algeria	1.1	1.3	1.3	1.4
Ecuador	0.2	0.2	0.2	0.3
Gabon	0.2	0.2	0.2	0.2
Indonesia	1.7	1.7	1.7	1.7
Iran	5.7	6.0	5.8	5.5
Iraq	2.3	3.1	3.5	4.0
Kuwait	2.0	2.3	2.3	2.3
Libya	2.1	2.5	2.5	2.5
Nigeria	2.1	2.3	2.3	2.5
Qatar	0.5	0.6	0.5	0.5
Saudi Arabia	9.4	9.5	10.5	10.5
UAE	2.0	2.3	2.5	2.7
Abu Dhabi	1.7	1.9	2.1	2.3
Dubai	0.3	0.3	0.3	0.3
Sharjah	Negl	0.1	0.1	0.1
Venezuela	2.3	2.4	2.3	2.3

[1] Including natural gas liquids.

Table B-3

OPEC: Low Oil Production Scenario [1]

Million b/d

		Projected		
	1977	1980	1982	1985
Total	**31.7**	**33.1**	**33.0**	**33.3**
Algeria	1.1	1.3	1.3	1.4
Ecuador	0.2	0.2	0.2	0.3
Gabon	0.2	0.2	0.2	0.2
Indonesia	1.7	1.7	1.7	1.7
Iran	5.7	5.8	5.5	5.0
Iraq	2.3	3.0	3.2	3.5
Kuwait	2.0	2.3	2.3	2.3
Libya	2.1	2.5	2.5	2.5
Nigeria	2.1	2.3	2.3	2.5
Qatar	0.5	0.6	0.5	0.5
Saudi Arabia	9.4	8.8	8.8	8.8
UAE	2.0	2.0	2.2	2.3
Abu Dhabi	1.7	1.6	1.8	1.9
Dubai	0.3	0.3	0.3	0.3
Sharjah	Negl	0.1	0.1	0.1
Venezuela	2.3	2.4	2.3	2.3

[1] Including natural gas liquids.

Table B-4

OECD:[1] Historical Energy Demand

Million b/d Oil Equivalent

	1960	1970	1973	1974	1975	1976
Total	**37.4**	**64.1**	**72.7**	**71.8**	**69.7**	**72.8**
United States	21.3	33.4	36.9	36.1	35.5	36.9
Japan	1.8	5.7	7.0	7.0	6.6	6.8
Western Europe	12.5	21.6	24.6	24.4	23.3	24.8
Canada	1.8	3.4	4.2	4.3	4.3	4.3

[1] Excluding Australia and New Zealand.

Table B-5

World Oil: Historical Supply and Demand

Million b/d

	1960	1970	1973	1974	1975	1976
OECD [1]						
Production [2]	8.8	13.2	13.5	13.0	12.3	12.3
Consumption	15.3	32.8	39.1	37.8	35.1	37.7
Net oil imports	6.5	19.6	25.6	24.8	22.8	25.4
Other developed [3]						
Production [2]	Negl	0.3	0.5	0.5	0.5	0.5
Consumption	0.4	0.9	1.0	1.1	1.1	1.1
Net oil imports	0.4	0.6	0.5	0.6	0.6	0.6
Non-OPEC LDCs						
Production [2]	1.1	2.9	3.1	3.2	3.5	3.8
Consumption	2.4	4.8	5.7	6.0	6.3	6.8
Net oil imports	1.3	1.9	2.6	2.8	2.8	3.0
Communist countries						
Production [2]	3.4	8.1	10.1	10.9	11.7	12.5
Consumption	3.0	7.3	9.6	10.1	10.7	11.3
Net oil imports	−0.4	−0.8	−0.5	−0.8	−1.0	−1.2
OPEC						
Consumption	0.7	1.1	1.7	1.8	1.9	2.1
Statistical discrepancy	0.2	1.2	1.4	1.9	0.4	1.3
OPEC production [2]	8.7	23.6	31.3	31.1	27.5	31.2

[1] Excluding Australia and New Zealand.
[2] Including natural gas liquids.
[3] Including Australia, Israel, New Zealand, and South Africa.

Table 8-6

World Oil Supply and Demand

Million b/d

		Projected		
	1977 [1]	1980	1982	1985
OECD [2]				
Production [3]	12.9	15.4	15.9	17.0
Consumption				
3.7 percent growth scenario [4]	39.2	42.9 [5]	44.7	48.5
4.2 percent growth scenario [4]	39.2	43.7 [5]	46.6	51.9
Net oil imports				
3.7 percent growth scenario [4]	26.3	27.5	28.8	31.5
4.2 percent growth scenario [4]	26.3	28.3	30.7	34.9
Other developed [6]				
Production [3]	0.5	0.5	0.5	0.5
Consumption	1.2	1.4	1.5	1.8
Net oil imports	0.7	0.9	1.0	1.3
Non-OPEC LDCs				
Production [3]	4.2	6.3	7.3	9.0
Consumption	7.2	8.4	9.5	11.3
Net oil imports	3.0	2.1	2.2	2.3
Communist countries				
Production [3]	13.1	14.4	14.2	13.4
Consumption	12.0	14.0	14.8	15.9
Net oil imports	−1.1	−0.4	0.6	2.5
OPEC				
Consumption	2.3	3.0	3.4	4.0
Required production [3]				
3.7 percent growth scenario [4]	31.7	33.1	36.0	41.6
4.2 percent growth scenario [4]	31.7	33.9	37.9	45.0

[1] Estimated. Totals for the year will not balance because of a 500,000 b/d statistical discrepancy.
[2] Excluding Australia and New Zealand.
[3] Including natural gas liquids.
[4] They imply constant OECD unemployment assuming the historic relationship between employment and GNP growth (OECD average 4.2 percent) or, alternatively, constant unemployment assuming a decline in the historic relationship of productivity to GNP growth (OECD average 3.7 percent).
[5] Including additions to strategic oil reserves of 600,000 b/d for the United States and 100,000 b/d each for Japan and Western Europe.
[6] Including Australia, Israel, New Zealand, and South Africa.

Table B-7

Free World: Oil Demand and Supply [1]

Million b/d

		Projected		
	1977 [2]	1980	1982	1985
Oil demand				
3.7 percent growth scenario [3]	50.4	55.7 [4]	59.1	65.6
4.2 percent growth scenario [3]	50.4	56.5 [4]	61.0	69.0
3.7 percent growth scenario [3]				
United States	18.2	21.6	22.3	22.8
Western Europe	13.9	13.6	14.2	16.2
Japan	5.3	5.8	6.4	7.4
Canada	1.8	1.9	1.8	2.1
4.2 percent growth scenario [3]				
United States	18.2	22.0	23.3	24.5
Western Europe	13.9	13.9	14.8	17.3
Japan	5.3	5.9	6.6	7.8
Canada	1.8	1.9	1.9	2.3
Other developed countries [5]	1.2	1.4	1.5	1.8
Non-OPEC LDCs	7.2	8.4	9.5	11.3
OPEC countries	2.3	3.0	3.4	4.0
Other [6]	0.5			
Oil Supply	18.7	22.6	23.1	24.0
United States	9.8	10.4	10.2	10.3
Western Europe	1.5	3.3	4.0	4.8
Of which:				
Norway	0.3	0.8	1.0	1.3
United Kingdom	0.8	2.1	2.7	3.0
Canada	1.6	1.7	1.7	1.9
Other developed countries [5]	0.5	0.5	0.5	0.5
Non-OPEC LDCs	4.2	6.3	7.3	9.0
Of which:				
Mexico	1.1	2.3	2.9	3.9
Net exports of Communist countries	1.1	0.4	−0.6	−2.5
Required OPEC production [7]				
3.7 percent growth scenario [3]	31.7	33.1	36.0	41.6
4.2 percent growth scenario [3]	31.7	33.9	37.9	45.0

[1] Including natural gas liquids.
[2] Estimated.
[3] They imply constant OECD unemployment assuming the historic relationship between employment and GNP growth (OECD average 4.2 percent) or, alternatively, constant unemployment assuming a decline in the historic relationship of productivity to GNP growth (OECD average 3.7 percent).
[4] Including additions to strategic oil reserves of 600,000 b/d for the United States and 100,000 b/d each for Japan and Western Europe.
[5] Including Australia, Israel, New Zealand, and South Africa.
[6] Statistical discrepancy.
[7] These data should not be viewed as projections of actual OPEC oil production, but merely as the level of production required to balance total Free World oil demand and supply.

Table B-8

OECD:[1] Net Oil Import Requirements

Million b/d

	1960	1970	1973	1974	1975	1976
Total						
Production[2]	**8.8**	**13.2**	**13.5**	**13.0**	**12.3**	**12.3**
Consumption	**15.3**	**32.8**	**39.1**	**37.8**	**35.1**	**37.7**
Net oil imports	**6.5**	**19.6**	**25.6**	**24.8**	**22.8**	**25.4**
United States						
Production[2]	8.0	11.3	11.0	10.5	10.0	9.8
Consumption	9.6	14.5	17.0	16.4	15.8	16.9
Net oil imports	1.6	3.2	6.0	5.9	5.8	7.1
Japan						
Production	Negl	Negl	Negl	Negl	Negl	Negl
Consumption	0.6	4.0	5.4	5.2	4.8	5.0
Net oil imports	0.6	4.0	5.4	5.2	4.8	5.0
Western Europe						
Production[2]	0.3	0.4	0.4	0.5	0.6	0.9
Consumption	4.2	12.7	14.9	14.3	12.7	14.0
Net oil imports	3.9	12.3	14.5	13.8	12.1	13.1
Canada						
Production[2]	0.5	1.5	2.1	2.0	1.7	1.6
Consumption	0.9	1.6	1.8	1.9	1.8	1.8
Net oil imports	0.4	0.1	−0.3	−0.1	0.1	0.2

[1] Excluding Australia and New Zealand.
[2] Including natural gas liquids.

Table B-9

OECD: [1] Net Oil Import Requirements

Million b/d

	1977 [2]	Projected 1980	1982	1985
Total				
Production [3]	**12.9**	**15.4**	**15.9**	**17.0**
Consumption				
3.7 percent growth scenario [4]	**39.2**	**42.9 [5]**	**44.7**	**48.5**
4.2 percent growth scenario [4]	**39.2**	**43.7 [5]**	**46.6**	**51.9**
Net oil imports				
3.7 percent growth scenario [4]	**26.3**	**27.5**	**28.8**	**31.5**
4.2 percent growth scenario [4]	**26.3**	**28.3**	**30.7**	**34.9**
United States				
Production [3]	9.8	10.4	10.2	10.3
Consumption				
3.7 percent growth scenario [4]	18.2	21.6	22.3	22.8
4.2 percent growth scenario [4]	18.2	22.0	23.3	24.5
Net oil imports				
3.7 percent growth scenario [4]	8.4	11.2	12.1	12.5
4.2 percent growth scenario [4]	8.4	11.6	13.1	14.2
Japan				
Production	Negl	Negl	Negl	Negl
Consumption				
3.7 percent growth scenario [4]	5.3	5.8	6.4	7.4
4.2 percent growth scenario [4]	5.3	5.9	6.6	7.8
Net oil imports				
3.7 percent growth scenario [4]	5.3	5.8	6.4	7.4
4.2 percent growth scenario [4]	5.3	5.9	6.6	7.8
Western Europe				
Production [3]	1.5	3.3	4.0	4.8
Consumption				
3.7 percent growth scenario [4]	13.9	13.6	14.2	16.2
4.2 percent growth scenario [4]	13.9	13.9	14.8	17.3
Net oil imports				
3.7 percent growth scenario [4]	12.4	10.3	10.2	11.4
4.2 percent growth scenario [4]	12.4	10.6	10.8	12.5
Canada				
Production [3]	1.6	1.7	1.7	1.9
Consumption				
3.7 percent growth scenario [4]	1.8	1.9	1.8	2.1
4.2 percent growth scenario [4]	1.8	1.9	1.9	2.3
Net oil imports				
3.7 percent growth scenario [4]	0.2	0.2	0.1	0.2
4.2 percent growth scenario [4]	0.2	0.2	0.2	0.4

[1] Excluding Australia and New Zealand.
[2] Estimated.
[3] Including natural gas liquids.
[4] The scenarios imply constant OECD unemployment assuming the historic relationship between employment and GNP growth (OECD average 4.2 percent) or, alternatively, constant unemployment assuming a decline in the historic relationship of productivity to GNP growth (OECD average 3.7 percent).
[5] Including additions to strategic oil reserves of 600,000 b/d for the United States and 100,000 b/d each for Japan and Western Europe.

Table B-10

Other Developed Countries: Net Oil Import Requirements

Thousand b/d

	1960	1970	1973	1974	1975	1976	1977[1]	Projected 1980	Projected 1982	Projected 1985
Total										
Production[2]	3	289	513	547	535	496	506	530	530	530
Consumption	370	885	1,045	1,065	1,095	1,142	1,205	1,395	1,545	1,815
Net oil imports	367	596	532	518	560	646	699	865	1,015	1,285
Australia										
Production[2]	0	195	420	440	450	480	490	500	500	500
Consumption	220	515	590	615	560	621	660	780	870	1,050
Net oil imports	220	320	170	175	110	141	170	280	370	550
Israel										
Production[2]	3	90	90	100	75	1	1	0	0	0
Consumption	35	100	135	130	130	133	135	150	160	175
Net oil imports	32	10	45	30	55	132	134	150	160	175
New Zealand										
Production[2]	0	4	3	7	10	15	15	30	30	30
Consumption	35	75	90	100	85	96	100	115	125	140
Net oil imports	35	71	87	93	75	81	85	85	95	110
South Africa										
Production	0	0	0	0	0	0	0	0	0	0
Consumption	80	195	230	220	320	292	310	350	390	450
Net oil imports	80	195	230	220	320	292	310	350	390	450

[1] Estimated.
[2] Including natural gas liquids.

Table B-11

Non-OPEC LDCs: Net Oil Import Requirements

Thousand b/d

	1960	1970	1973	1974	1975	1976	1977[1]	Projected 1980	1982	1985
Total										
Production[2]	1,142	2,947	3,091	3,178	3,320	3,790	4,202	6,251	7,286	9,011
Consumption	2,400	4,800	5,780	6,000	6,300	6,765	7,160	8,430	9,510	11,300
Net oil imports	1,258	1,853	2,689	2,822	2,771	2,975	2,958	2,149	2,224	2,289
Argentina										
Production[2]	175	395	433	419	400	400	440	450	440	430
Consumption	243	423	492	482	455	453	470	530	570	630
Net oil imports	68	28	59	63	55	53	30	80	130	200
Brazil										
Production[2]	80	169	171	177	179	176	172	235	355	505
Consumption	273	508	772	830	867	972	1,040	1,250	1,460	1,750
Net oil imports	193	339	601	653	688	796	868	1,015	1,105	1,245
Colombia										
Production[2]	155	227	205	179	172	160	151	155	155	155
Consumption	53	96	135	137	140	145	150	180	200	230
Net oil imports	−102	−131	−70	−42	−32	−15	−1	25	45	75
Egypt										
Production[2]	65	326	165	145	250	330	418	700	900	1,000
Consumption	94	113	132	141	145	196	200	200	220	250
Net oil imports	29	−213	−33	−4	−105	−134	−218	−500	−680	−750
India										
Production[2]	9	144	149	156	165	175	199	320	430	500
Consumption	164	367	455	459	499	515	540	620	690	800
Net oil imports	155	223	306	303	334	340	341	300	260	300
Mexico										
Production[2]	298	544	535	660	800	935	1,075	2,340	2,860	3,940
Consumption	297	503	607	672	735	798	840	970	1,070	1,240
Net oil imports	−1	−41	72	12	−65	−137	−235	−1,370	−1,790	−2,700
Peru										
Production[2]	52	72	70	77	73	75	86	200	200	200
Consumption	50	97	111	121	116	118	120	140	160	180
Net oil imports	−2	25	41	44	43	43	34	−60	−40	−20
Philippines										
Production	0	0	0	0	0	0	0	0	0	0
Consumption	54	169	176	175	188	201	210	260	300	360
Net oil imports	54	169	176	175	188	201	210	260	300	360
South Korea										
Production	0	0	0	0	0	0	0	0	0	0
Consumption	14	199	281	287	311	358	390	490	580	750
Net oil imports	14	199	281	287	311	358	390	490	580	750
Taiwan										
Production[2]	0	2	4	5	7	7	7	7	7	7
Consumption	21	93	185	198	197	263	300	410	510	700
Net oil imports	21	91	181	193	190	256	293	403	503	693
Thailand										
Production	0	0	0	0	0	0	0	0	0	0
Consumption	23	108	169	177	176	176	200	280	350	490
Net oil imports	23	108	169	177	176	176	200	280	350	490
Other										
Production[2]	308	1,068	1,359	1,360	1,483	1,532	1,654	1,874	1,939	2,274
Consumption	1,114	2,124	2,185	2,321	2,471	2,570	2,700	3,100	3,400	3,920
Net oil imports	806	1,056	826	961	988	1,038	1,046	1,226	1,461	1,646

[1] Estimated.
[2] Including natural gas liquids.

Table B-12

Communist Countries: Oil Supply and Demand

Million b/d

	1960	1970	1973	1974	1975	1976	1977[1]	Projected 1980	Projected 1982	Projected 1985
Total										
Production	3.4	8.1	10.1	10.9	11.7	12.5	13.1	14.4	14.2	13.4
Consumption	3.0	7.3	9.6	10.1	10.7	11.3	12.0	14.0	14.8	15.9
Net Exports	0.4	0.8	0.5	0.8	1.0	1.2	1.1	0.4	−0.6	−2.5
Communist	0	0	0	0	0	0	0	0	0	0
Free world	0.4	0.8	0.5	0.8	1.0	1.2	1.1	0.4	−0.6	−2.5
USSR										
Production[2]	3.0	7.1	8.6	9.2	9.8	10.4	10.9	11.5	11.0	10.0
Consumption	2.3	5.2	6.4	6.9	7.3	7.6	7.9	9.1	9.5	10.0
Net Exports	0.7	1.9	2.2	2.3	2.5	2.8	3.0	2.4	1.5	0
Other Communist	0.3	1.1	1.4	1.5	1.5	1.7	1.8	1.9	1.7	1.4
Free World	0.4	0.8	0.8	0.8	1.0	1.1	1.2	0.5	−0.2	−1.4
Eastern Europe[3]										
Production[2]	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3
Consumption	0.4	1.2	1.8	1.8	1.9	2.0	2.2	2.5	2.7	3.0
Net Exports	−0.1	−0.8	−1.4	−1.4	−1.5	−1.6	−1.8	−2.1	−2.3	−2.7
Other Communist	−0.1	−0.8	−1.2	−1.3	−1.4	−1.5	−1.5	−1.6	−1.5	−1.2
Free World	Negl	Negl	−0.2	−0.1	−0.1	−0.1	−0.3	−0.5	−0.8	−1.5
China										
Production	0.1	0.6	1.1	1.3	1.5	1.7	1.8	2.5	2.8	3.1
Consumption	0.2	0.6	1.1	1.2	1.3	1.5	1.6	2.0	2.2	2.6
Net Exports	−0.1	Negl	Negl	0.1	0.2	0.2	0.2	0.5	0.5	0.5
Other Communist	−0.1	0	Negl	Negl	Negl	Negl	Negl	Negl	0.1	0.1
Free World	0	Negl	Negl	0.1	0.2	0.2	0.2	0.5	0.4	0.4
Other[4]										
Production	Negl	Negl	Negl	Negl	Negl	Negl	Negl	Negl	Negl	Negl
Consumption	0.1	0.3	0.3	0.2	0.2	0.2	0.3	0.3	0.3	0.3
Net Exports	−0.1	−0.3	−0.3	−0.2	−0.2	−0.2	−0.3	−0.3	−0.3	−0.3
Other Communist	−0.1	−0.3	−0.2	−0.2	−0.1	−0.2	−0.3	−0.3	−0.3	−0.3
Free World	0	0	−0.1	Negl	−0.1	Negl	Negl	Negl	Negl	Negl

[1] Estimated.
[2] Including natural gas liquids.
[3] Including Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, Romania, and Yugoslavia.
[4] Including Albania, Cuba, Cambodia, Laos, Mongolia, North Korea, and Vietnam.

Table B-13

OECD:[1] Energy Production and Net Nonoil Energy Imports

Million b/d Oil Equivalent

								Projected		
	1960	1970	1973	1974	1975	1976	1977[2]	1980	1982	1985
Total energy production	30.8	43.7	46.2	45.9	45.8	46.0	47.4	53.2	55.5	59.4
Oil[3]	8.8	13.2	13.5	13.0	12.3	12.3	12.9	15.4	15.9	17.0
Natural gas	6.9	13.4	15.5	15.3	14.6	14.6	15.0	15.2	14.9	14.1
Coal	12.4	12.6	11.7	11.5	12.3	12.5	12.3	13.2	14.0	15.4
Hydro, geothermal	2.7	4.2	4.6	4.9	4.9	4.7	5.0	5.5	5.8	6.3
Nuclear	Negl	0.3	0.9	1.2	1.7	1.9	2.2	3.9	4.9	6.6
United States	20.1	30.6	31.0	30.4	29.9	29.9	30.1	31.6	32.3	34.1
Oil[3]	8.0	11.3	11.0	10.5	10.0	9.8	9.8	10.4	10.2	10.3
Natural gas	6.4	11.0	11.4	10.9	10.1	10.0	10.0	9.4	9.0	8.4
Coal	4.9	6.9	6.7	6.8	7.3	7.6	7.5	8.3	9.1	10.4
Hydro/geothermal	0.8	1.3	1.5	1.6	1.6	1.5	1.5	1.7	1.7	1.8
Nuclear	Negl	0.1	0.4	0.6	0.9	1.0	1.3	1.8	2.3	3.2
Japan	1.0	0.9	0.8	0.9	0.9	1.0	1.0	1.3	1.3	1.6
Oil[3]	Negl	Negl	Negl	Negl	Negl	Negl	Negl	Negl	Negl	Negl
Natural gas	Negl	Negl	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Coal	0.7	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Hydro/geothermal	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.6
Nuclear	0	Negl	Negl	0.1	0.1	0.2	0.1	0.4	0.4	0.6
Western Europe	8.3	8.7	9.6	9.8	10.4	10.6	11.6	15.0	16.3	17.8
Oil[3]	0.3	0.4	0.4	0.5	0.6	0.9	1.5	3.3	4.0	4.8
Natural gas	0.2	1.3	2.5	2.8	2.9	3.0	3.3	3.8	3.8	3.6
Coal	6.7	5.1	4.5	4.2	4.4	4.3	4.2	4.3	4.3	4.3
Hydro/geothermal	1.1	1.7	1.8	1.9	1.9	1.8	1.9	2.1	2.2	2.4
Nuclear	Negl	0.2	0.4	0.4	0.6	0.6	0.7	1.5	2.0	2.5
Canada	1.4	3.5	4.8	4.8	4.6	4.5	4.7	5.3	5.6	5.9
Oil[3]	0.5	1.5	2.1	2.0	1.7	1.6	1.6	1.7	1.7	1.9
Natural gas	0.3	1.1	1.5	1.5	1.5	1.5	1.6	1.9	2.0	1.8
Coal	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4
Hydro/geothermal	0.5	0.8	0.9	1.0	1.0	1.0	1.1	1.2	1.4	1.5
Nuclear	0	Negl	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3
Total net nonoil energy imports	0.2	0.6	1.0	1.0	1.1	1.4	1.7	2.7	3.1	3.7
Natural gas	0	0	0.2	0.2	0.3	0.5	0.6	1.5	1.8	2.3
Coal	0.2	0.6	0.8	0.8	0.8	0.9	1.1	1.2	1.3	1.4
United States	−0.3	−0.4	−0.1	−0.3	−0.3	−0.2	−0.1	0.1	0	0.3
Natural gas	0.1	0.4	0.5	0.4	0.4	0.5	0.5	0.8	0.8	1.1
Coal	−0.4	−0.8	−0.6	−0.7	−0.7	−0.7	−0.6	−0.7	−0.8	−0.8
Japan	0.1	0.7	0.9	1.0	0.9	0.9	1.0	1.3	1.4	1.6
Natural gas	0	Negl	0.1	0.1	0.1	0.1	0.2	0.4	0.4	0.5
Coal	0.1	0.7	0.8	0.9	0.8	0.8	0.8	0.9	1.0	1.1
Western Europe	0.3	0.5	0.6	0.8	0.9	1.1	1.3	1.8	2.1	2.3
Natural gas	Negl	Negl	0.1	0.2	0.3	0.4	0.4	0.8	1.0	1.1
Coal	0.3	0.5	0.5	0.6	0.6	0.7	0.9	1.0	1.1	1.2
Canada	0.1	−0.2	−0.4	−0.5	−0.4	−0.4	−0.5	−0.5	−0.4	−0.5
Natural gas	−0.1	−0.4	−0.5	−0.5	−0.5	−0.5	−0.5	−0.5	−0.4	−0.4
Coal	0.2	0.2	0.1	Negl	0.1	0.1	Negl	Negl	Negl	−0.1

[1] Including Australia and New Zealand.
[2] Estimated.
[3] Including natural gas liquids.

APPENDIX C

THE OIL MARKET THROUGH 1985 COMPARED WITH *THE INTERNATIONAL ENERGY SITUATION: OUTLOOK TO 1985*

This assessment reaches essentially the same conclusion as our last published report on this subject (ER 77-10240, *The International Energy Situation: Outlook to 1985,* Unclassified, April 1977). Nevertheless, there are a number of differences between the two reports. One principal difference is that the current assessment does not treat Saudi Arabia as the residual energy supplier.

In the April 1977 study, a required OPEC production level to meet non-Communist oil demand was projected in a manner similar to that used in this assessment. It was assumed that all OPEC countries except Saudi Arabia would produce at capacity to meet demand and that Saudi Arabia would be called upon to supply the remaining oil to balance the market. This amount of oil—19 million to 23 million b/d in the April 1977 study—was not a projection of output, and the earlier study clearly indicated that such levels of production were extremely unlikely.

A second difference between the two reports is that our baseline energy demand equations in the current assessment explicitly include a price term. In the previous report, all price-induced conservation was estimated judgmentally. Comparative details as to how the OECD energy demand projections were arrived at in the two studies can be found in appendix A and on pages 4 and 5 of the April 1977 report.

Finally, there are of course numerous differences in the actual projected values of various oil supply/demand factors. Most of these differences are relatively small and in some cases offsetting (see table). The most notable revisions in our projections since the April 1977 report are:

- Lowering the OECD energy demand range, due largely to reductions in expectations of real GNP growth in 1978-85.
- Lowering OECD coal supplies, chiefly as a result of less optimism about prospects in the US coal industry.
- A reduction in Communist countries' net oil imports.
- A reduction in Saudi Arabian and other OPEC productive capacity projections.

Table C-1

CIA Energy Demand and Supply Projections for 1985: Current Assessment Compared With April 1977 Report

Million b/d Oil Equivalent

	April 1977	August 1976	Approximate Effect of Changes on World Oil Balance
Saudi sustainable capacity	16-18 [1]	10½-12½	−5½
Other OPEC sustainable capacity	27½-29½	24½-27½	−2½
Communist net oil imports	3½-4½	2½	1½
Non-OPEC LDC net oil imports	3½	2½	1.0
OECD oil production	16-18	17.0	0
OECD nonoil energy supplies	47½-49.0	46.0	−2.0
OECD energy demand	99½-102.0	95.0-98.0	2½

[1] This estimate did not explicitly distinguish between installed (facility) and sustainable capacity. Conceptually, however, sustainable capacity was at the lower end of this range and facility capacity at the higher end.

APPENDIX D

WORLD DEMAND FOR OPEC OIL
COMPARATIVE PROJECTIONS AND ASSUMPTIONS

We have compared our projections of the demand for OPEC oil with those of a number of other forecasting groups. These comparisons (see table D-1) show considerable variation in the projections of 1985 demand for OPEC oil, ranging from the 38.3 million b/d projected by Oil Company D to 46.3 million b/d projected at the high end of the International Energy Agency

Table D-1

World Demand for OPEC Oil: Comparative Projections and Assumptions

			Average Annual Percent Change During 1976-85				Average Annual Percent Change During 1976-85			1985
	World Demand for OPEC Oil in 1985 (Million b/d)	OECD Oil Import Demand in 1985 (Million b/d)	OECD Energy Demand	OECD Real GNP	OECD Energy [1] Conservation	US Oil Import Demand in 1985 (Million b/d)	US Energy Demand	US Real GNP	US Energy [1] Conservation Gain	Communist Net Oil Trade (Million b/d)
CIA (3.7-percent OECD real GNP growth) [2]	41.6	31.5	3.1	3.9	−0.8	12.5	2.8	3.7	−0.9	−2.5
CIA (4.2-percent OECD real GNP growth) [3]	45.0	34.9	3.5	4.3	−0.8	14.2	3.2	4.1	−0.9	−2.5
International Energy Agency	41.8-46.3	NA	NA	4.3	NA	NA	NA	NA	NA	−1.0
Energy Information Administration	44.5	34.3	3.6	4.2	−0.5	11.0	3.0	4.2	−1.2	−2.5
Congressional Research Service	42.8	34.6	NA	4.0	NA	11.8	NA	3.5	NA	NA
Company A	40.0	33.3	3.0 [4]	3.8 [4]	−0.8 [4]	12.5	2.4 [4]	3.8 [4]	−1.5 [4]	1.0
Company B	45.2	34.8	4.0	4.3	−0.3	10.3	3.0	4.0	−1.0	0.5
Company C	43.3	34.8	3.5 [4]	4.0 [4]	−0.5 [4]	10.8	2.9 [4]	3.8 [4]	−0.9 [4]	0
Company D	38.3	32.6	3.3 [4]	NA	NA	10.7	2.6 [4]	NA	NA	NA

NA—Not available.

[1] Change in energy demand/real GNP ratio.

[2] Based on scenarios that imply constant OECD unemployment assuming the historic relationship between employment and GNP growth (OECD average 4.2 percent) or, alternatively, constant unemployment assuming a decline in the historic relationship of productivity to GNP growth (OECD average 3.7 percent).

[3] 1977-85.

[4] 1977-90.

(IEA) range. The projections of demand for OPEC oil in our OECD growth scenarios fall comfortably within this range.

Much of the variation among the projections for demand results from differences in underlying assumptions. A major source of difficulty in making comparisons, however, is that different measures of energy demand are used by different forecasting groups. We have made comparisons of energy demand projections in physical units only where definitional, measurement and conversion problems are minimal, such as for oil import demand and world demand for OPEC oil. Where these problems are substantial, as in the measures of total energy demand, we show comparisons only of the percentage increases used in the demand projection.

The variations among projections of demand for OPEC oil can be analyzed in terms of (a) the economic growth assumptions, (b) the conservation assumptions, (c) the nonoil supply assumptions, and (d) the estimates of Communist countries' net oil trade.

Economic Growth and Conservation

Most other forecasters assume rates of OECD economic growth between those used in our two growth scenarios, with IEA and the Energy Information Agency at or near the higher. Differences on conservation are largely offsetting for the OECD as a whole, with our conservation projections being on the optimistic side. We assumed slightly lower conservation gains in the United States than do the other projections presented. This is more than offset, however, by our assumption of continued conservation gains in other OECD regions, in sharp contrast to the little or no new conservation assumed by others for elsewhere in the OECD.

OECD Oil Import Demand

Other projections of OECD oil import demand fall within our range, but are closest to the projection associated with the higher of our two growth scenarios. This indicates a similarity not only in projections of energy demand but also in those of OECD energy production, differences for particular energy sources tending to be offsetting. Our relatively high projection of US import demand reflects not only a comparatively low US conservation estimate but also a lower US coal production projection than is carried by some other forecasters.

Communist Oil Trade

One noteworthy source of the variation in the projections of world demand for OPEC oil is the divergent assumptions on Communist countries' net oil trade. We and the IEA estimate that the Communist area will have net oil imports of 2.5 million b/d in 1985; the IEA also projects net imports by

these countries, but on a smaller scale. In contrast, the oil company projections show balanced Communist area net oil trade or continued net exports.

Implications of the Differences

Given the similarity of various projections of the demand for OPEC oil, differences in the conclusions of various studies as to the future supply and demand balance revolve around forecasts of the OPEC supply outlook. On this there is less unanimity. IEA projections of OPEC supply are similar to ours (37 million to 39 million b/d by 1985). Oil company projections of OPEC supply are generally higher (44 million to 48 million b/d by 1985). These differences may stem more from the nature of the question addressed—what is technically feasible and what is likely to result from policies of host country governments—than from different answers to the latter question. Differences on the role of the Communist countries are much less significant to the outcome of various analyses since the impact of one answer or another to the Communist question serves only to shift the date of any potential supply shortfall by a year or so.

APPENDIX E

ENERGY SUPPLY AND CONSUMPTION IN THE USSR

Energy Consumption

Soviet energy use was projected for 1980 and 1985 using assumed real GNP growth rates of 4 percent during 1976-80 and 3 to 3.5 percent during 1981-85. Energy consumption in the USSR has traditionally risen slightly faster than GNP, primarily because of the emphasis given to the expansion of energy intensive heavy industry. This rise in the energy consumption/real GNP ratio has occurred despite the rapid shift in the USSR away from coal and toward the use of oil and gas, which burn more efficiently than coal. It has also occurred despite a massive investment in cogeneration and the electrification of railways, measures which also improved energy efficiency. In contrast to Western economies, where the energy intensiveness of output has dropped markedly since 1973, in the Soviet Union energy consumption continued to rise more rapidly than GNP after 1973.

Soviet Energy Conservation

The USSR has become increasingly seized by the need to increase energy efficiency, particularly since 1975, as increased energy exports were called upon to help improve the Soviet hard currency trade balance. Over the past two years several steps have been taken to tighten fuel allocations and fuel stocks have been drawn down, situations that have led to reporting of isolated fuel shortages since mid-1976. Preliminary 1977 data show a sharp slowing in energy consumption, to 3.3 percent (GNP growth was also 3.3 percent). The Soviets carried out a strenuous conservation effort in 1977, and we believe they realized a large number of one-time gains in efficiency that are not likely

Table E-1

Real GNP and Energy Consumption: Comparative Rates of Growth

Average Annual Percent Change

	1961-73		1974-76	
	Real GNP	Energy Consumption	Real GNP	Energy Consumption
USSR	5.0	5.2	3.3	4.7
United States	4.0	4.3	1.0	Negl
Japan	10.3	11.2	2.5	−0.6

to be repeated in the future. Indeed, some of the fuel savings through tightened allocations may only have postponed consumption. Thus far in 1978, additional steps have been taken, including the doubling of gasoline prices (a largely symbolic measure) and the initiation of a program to improve the efficiency of engine design.

Future improvements in fuel efficiency will be relatively small, so long as industrial priorities continue to give emphasis to energy-intensive heavy industry. Soviet energy experts such as N. V. Mel'nikov (an Academy of Sciences member) and M. A. Vilenskiy predicted in 1976 that energy consumption in the USSR would rise by at least 4.5 percent through the 1980s and that energy consumption would rise faster than real GNP. [1] In December 1977, during the US-USSR energy exchanges, US officials were told that Soviet energy consumption during the 1976-80 and the 1981-85 plans would continue to grow at the rate of 4 to 6 percent a year.

We projected future Soviet energy consumption on the basis of past energy/GNP relationships, and then assumed energy savings of about 2.5 percent by 1985, all in the form of oil. Larger savings are undoubtedly possible, but would almost certainly require a shift in industrial priorities. The 1978 plan allows for no such shift; nor does the 1976-80 five-year plan. As a result, we project energy consumption growth of slightly more than GNP during 1976-80 (4.1-percent average annual rate), slightly less than GNP during 1981-85 (3.2 percent for energy compared with 3 to 3.5 percent for GNP). [2] The result is a rise in Soviet domestic energy requirements from 21.2 million b/d oil equivalent in 1976 to 24.7 million b/d in 1980 and 28.9 million b/d in 1985.

Our projections of the Soviet energy balance in 1980 and 1985 are shown in table E-2. Like all projected balances, it must be considered merely indicative. Trends are clear, and we remain highly confident of our forecast that Soviet oil output will fall to a range of 8 million to 10 million b/d by 1985. However, the precise outcome of the many variables—economic growth, industrial priorities, conservation programs, and production of alternative energy sources—makes predictions of net oil trade extremely uncertain. What we have projected is a plausible outcome for the USSR's energy balance, under the stated assumptions of GNP growth and with Soviet oil output at the high end of the range of likely outcomes. With lower oil output, economic growth would almost certainly be adversely affected, resulting in lower energy consumption.

This projection differs from the projections underlying those presented in *Soviet Economic Problems and Prospects* mainly in only two respects. The energy demand and economic growth projections are identical, but the

[1] See Leslie Dienes, "Another Energy Crunch?", *Problems of Communism*, Sept-Oct 1977, p. 44.

[2] Although Soviet GNP thus far into the five-year plan appears to be growing somewhat slower than the 4 percent we projected for the five years, energy consumption, according to official data for 1976 and partial data for 1977, appears to have risen slightly faster than the 4.1 percent projected.

Table E-2

USSR: Energy Balance

Million b/d Oil Equivalent

	1970[1]	1971[1]	1972[1]	1973[1]	1974[1]	1975[1]	1976[1]	1977	1980 (Plan)	1980 (Estimated)	1985 (Estimated)
Total supply	18.5	19.4	20.4	21.5	22.5	23.8	24.8	26.1	30.9	28.7	30.5-33.5[6]
Production	18.2	19.1	19.9	20.9	22.0	23.3	24.4	25.6	30.3	28.1	27.9-29.9[3]
Crude oil and condensate	7.1	7.6	8.0	8.6	9.2	9.8	10.4	10.9[4]	12.8[4]	11.5	8.0-10.0[4]
Natural gas	3.3	3.5	3.7	4.0	4.4	4.8	5.3	5.7[4]	7.3[4]	7.0	9.4
Coal	6.0	6.2	6.3	6.4	6.5	6.6	6.7	6.8[4]	7.5[4]	7.0	7.2
Peat, shale, and fuelwood	0.7	0.7	0.8	0.8	0.7	0.8	0.7	0.7[4]	0.8[4]	0.8	0.8
Hydro[5]	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7[4]	0.9[4]	0.9	1.2
Nuclear[5]	0	0	0	0	0.1	0.1	0.1	0.2[4]	0.4[4]	0.3	0.7
Other sources	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6[4]	0.6[4]	0.6	0.6
Imports	0.3	0.3	0.5	0.6	0.5	0.5	0.4	0.5	0.6	0.6	2.6
Crude oil and petroleum products	0.1	0.1	0.2	0.3	0.1	0.2	0.1	0.2[4]	0.3[4]	0.3	1.9
Natural gas	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2[4]	0.2[4]	0.2	0.5
Coal and coke	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1[4]	0.1[4]	0.1	0.2
Total requirements	18.5	19.4	20.4	21.5	22.5	23.8	24.8	26.1	30.9	28.7	33.5
Consumption	16.1	16.8	17.7	18.5	19.4	20.3	21.2	21.9	25.7	24.8	28.9
Crude oil and condensate	5.2	5.5	6.0	6.4	6.9	7.4	7.7	8.0[4]	9.3[4]	9.2	10.0
Natural gas	3.3	3.6	3.8	4.0	4.3	4.5	5.0	5.3[4]	6.6[4]	6.3	8.6
Coal	5.7	5.9	6.0	6.1	6.2	6.3	6.5	6.5[4]	7.2[4]	6.7	7.0
Other	1.9	1.9	1.9	2.0	2.0	2.1	2.0	2.1[4]	2.6[4]	2.6	3.3
Exports	2.4	2.6	2.7	2.9	3.0	3.3	3.8	4.2	5.2	3.9	3.6
Crude oil and petroleum products	1.9	2.1	2.2	2.4	2.3	2.6	3.0	3.2[4]	3.8[4]	2.6	1.9
Natural gas	0.1	0.1	0.1	0.1	0.3	0.3	0.4	0.6[4]	1.0[4]	0.9	1.3
Coal and coke	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4[4]	0.4[4]	0.4	0.4
Additions to stocks	0	0	0	0.1	0.1	0.2	−0.2	0 [4]	0 [4]	0	0
Net exports	2.1	2.2	2.2	2.3	2.5	2.8	3.3	3.7	4.5	3.3	1.0
Crude oil and petroleum products	1.8	2.0	2.0	2.1	2.2	2.4	2.8	3.0	3.5	2.3	0
Natural gas	0	−0.1	−0.1	−0.1	0	0.1	0.2	0.4	0.7	0.7	0.8
Coal and coke	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2

[1] Derived from official Soviet statistical yearbooks.
[2] In computing this indicated energy balance for 1985, we have assumed oil production at the high end of the range of likely outcome—8.0 to 10.0 million b/d. In the event that oil production drops sooner and falls short of 10 million b/d, the USSR will probably be forced to reduce economic growth.
[3] From Soviet statistical reports.
[4] From official Soviet plans.
[5] Estimated.
[6] Converted at factors corresponding to the average amount of fuel required to produce electricity in thermal power plants in the USSR.

anticipated output of alternative energy, primarily coal, is substantially reduced, and the projections have incorporated the high end of our oil production forecast for 1985, rather than the midpoint.

The lowering of the coal forecast is based primarily on the dismal performance of the Soviet coal industry in the first half of the 1976-80 plan period. *Soviet Problems and Prospects* assumed that the USSR would manage to achieve or nearly achieve its 1980 plan output for raw coal of 805 million

tons, up from 701 million in 1975. As of the first quarter of 1978, output is only running at a 725-million-ton annual rate, and we now project that Soviet raw coal output will fall short of the plan goal for 1980 by about 40 million tons, and our projection for 1985 has been lowered by some 100 million tons.

This pessimism over the outlook for Soviet coal production has been reflected in statements by the Soviet Coal Minister who has significantly lowered his coal output forecasts in the past few months. In 1975/76 he repeatedly said that output would reach 1 billion tons by 1990. In the past few months, he has stated that the billion-ton target will be reached "by the end of the century."

Scenarios of World Demand for OPEC Oil
(Constant Price of OPEC Oil)

Figure 1

Supply Exceeds Demand: +
Ex Ante Demand Exceeds Supply: –

Supply Scenarios	1978	1979	1980	1981	1982	1983	1984	1985
OECD Real GNP Growth 3.7 Percent[1]								
High OPEC Supply	+	+	+	+	+	+	+	–
Medium OPEC Supply	+	+	+	+	–	–	–	–
Low OPEC Supply	+	+	+	–	–	–	–	–
OECD Real GNP Growth 4.2 Percent[1]								
High OPEC Supply	+	+	+	+	–	–	–	–
Medium OPEC Supply	+	+	+	+	–	–	–	–
Low OPEC Supply	+	+	–	–	–	–	–	–

World Demand for OPEC Oil Allowing for Additional Conservation[2]

Supply Exceeds Demand: +
Ex Ante Demand Exceeds Supply: –

Supply Scenarios	1978	1979	1980	1981	1982	1983	1984	1985
OECD Real GNP Growth 3.7 Percent[1]								
High OPEC Supply	+	+	+	+	+	+	+	+
Medium OPEC Supply	+	+	+	+	+	+	–	–
Low OPEC Supply	+	+	+	–	–	–	–	–
OECD Real GNP Growth 4.2 Percent[1]								
High OPEC Supply	+	+	+	+	+	+	–	–
Medium OPEC Supply	+	+	+	+	–	–	–	–
Low OPEC Supply	+	+	–	–	–	–	–	–

1. These growth rates were calculated from projections of specific age population trends, projections of participation rates, and the use of historic GNP to employment relationships. They imply constant OECD unemployment assuming the historic relationship between employment and GNP growth (OECD average 4.2 percent) or, alternatively, constant unemployment assuming a decline in the historic relationship of productivity to GNP growth (OECD average 3.7 percent).
2. World energy demand adjusted for a 2.5-percent reduction in OECD energy demand in 1985; amounts rising linearly to this level in 1985. This would be the approximate effect of energy legislation now pending in Congress, according to Department of Energy estimates.

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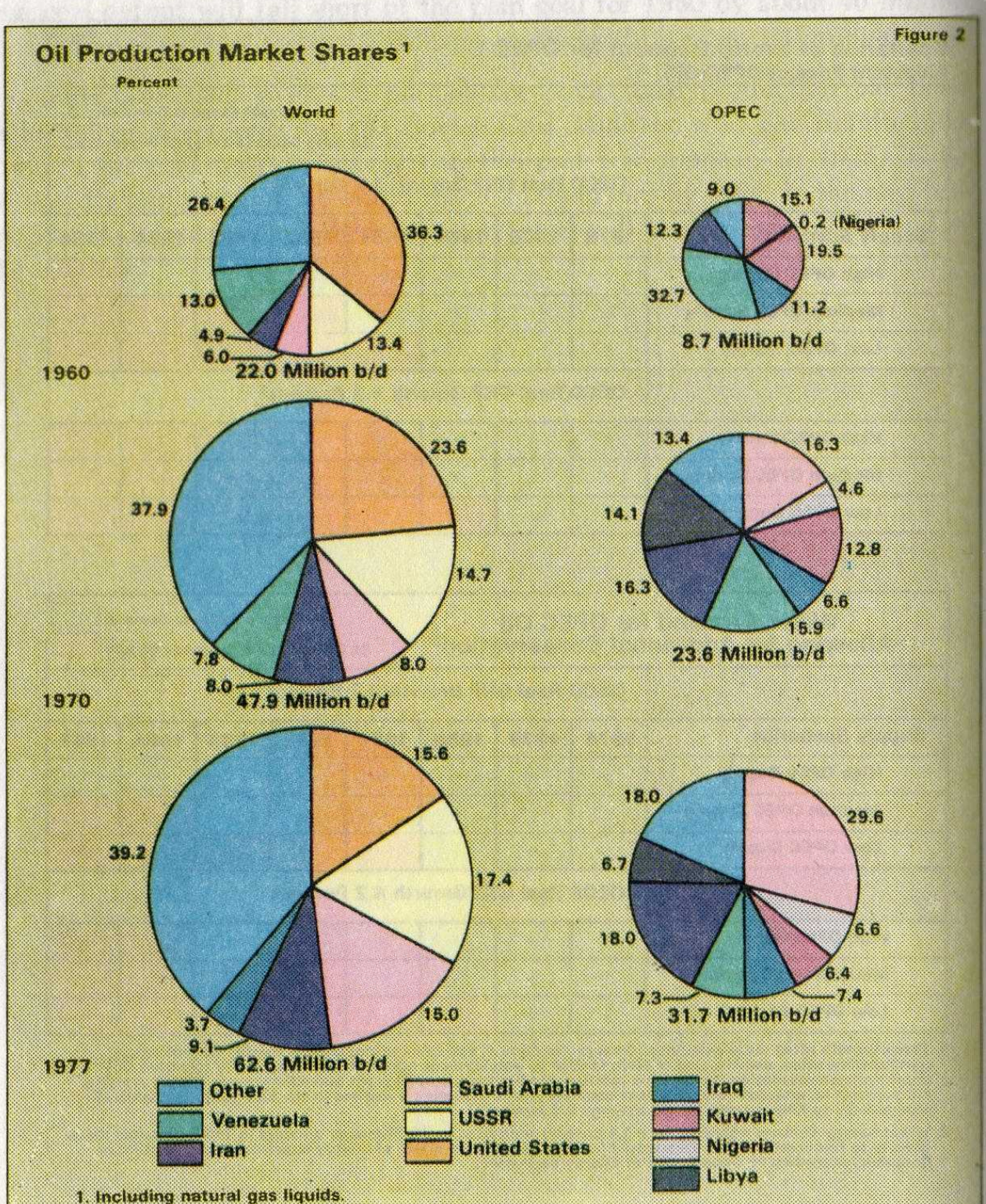
Figure 2

Oil Production Market Shares[1]

Percent



1. Including natural gas liquids.

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Saudi Arabia: Selected Oilfields

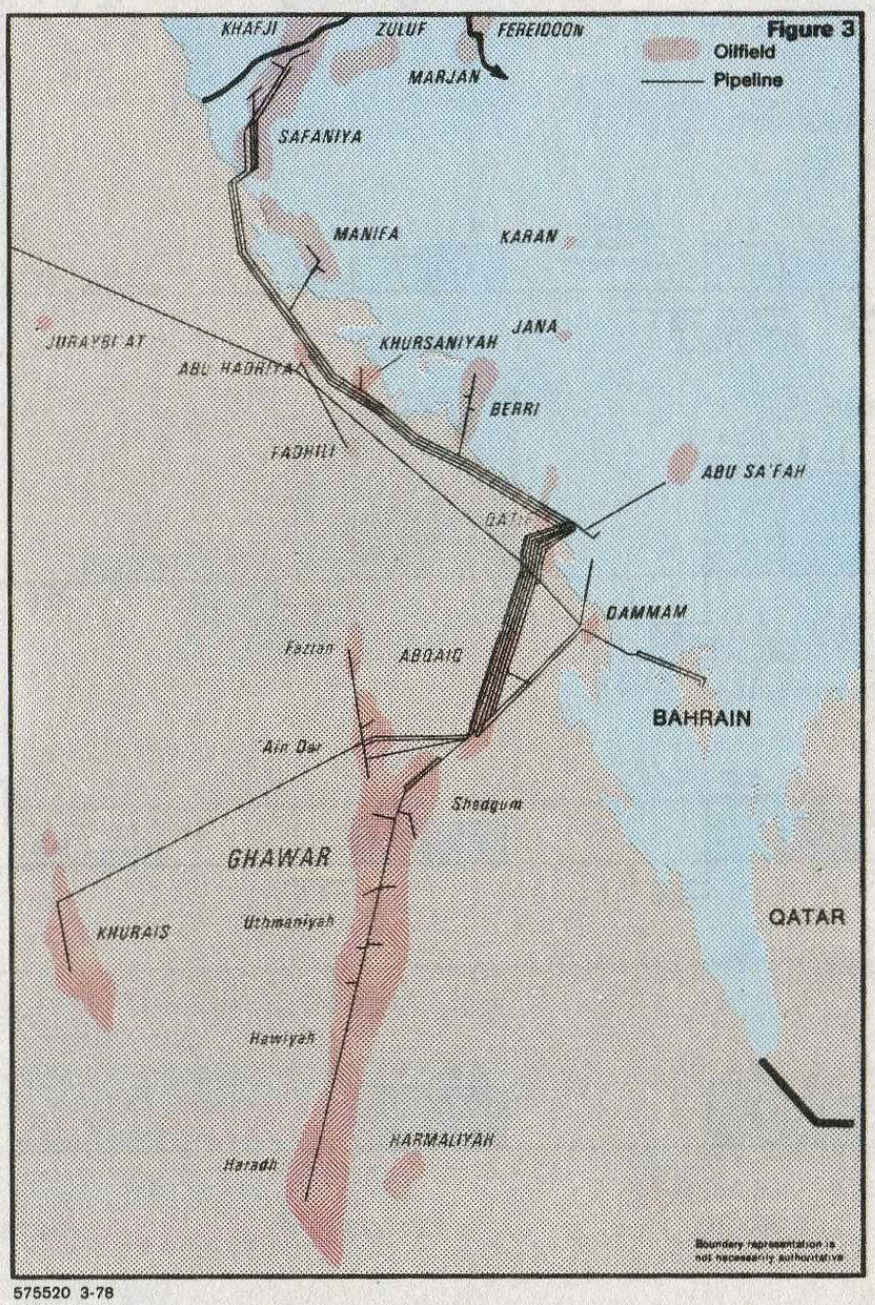

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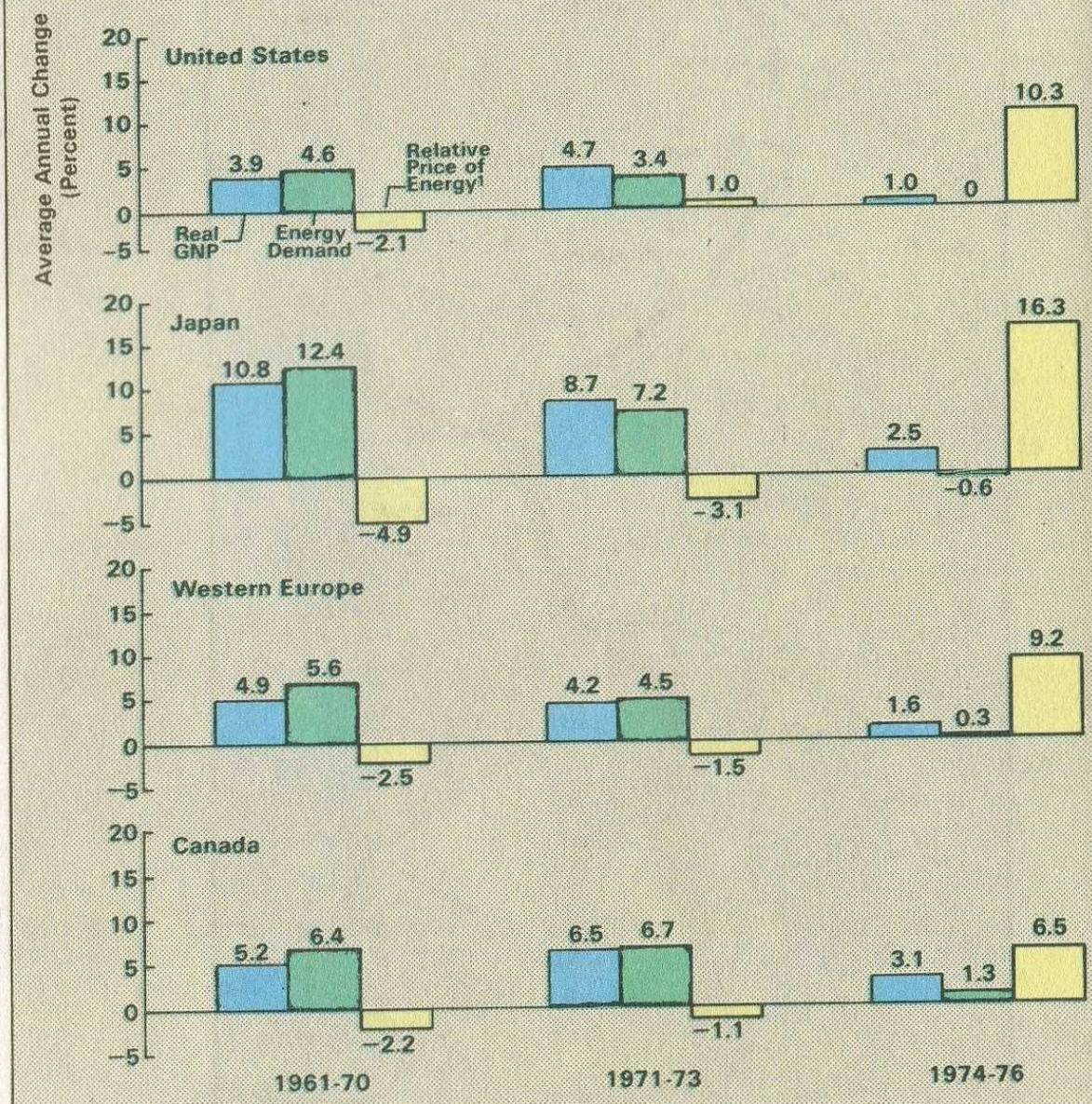
Figure 4

OECD: Growth in Real GNP, Energy Demand, and Relative Price of Energy



1. Ratio of the index of aggregate price of energy to the GNP deflator.

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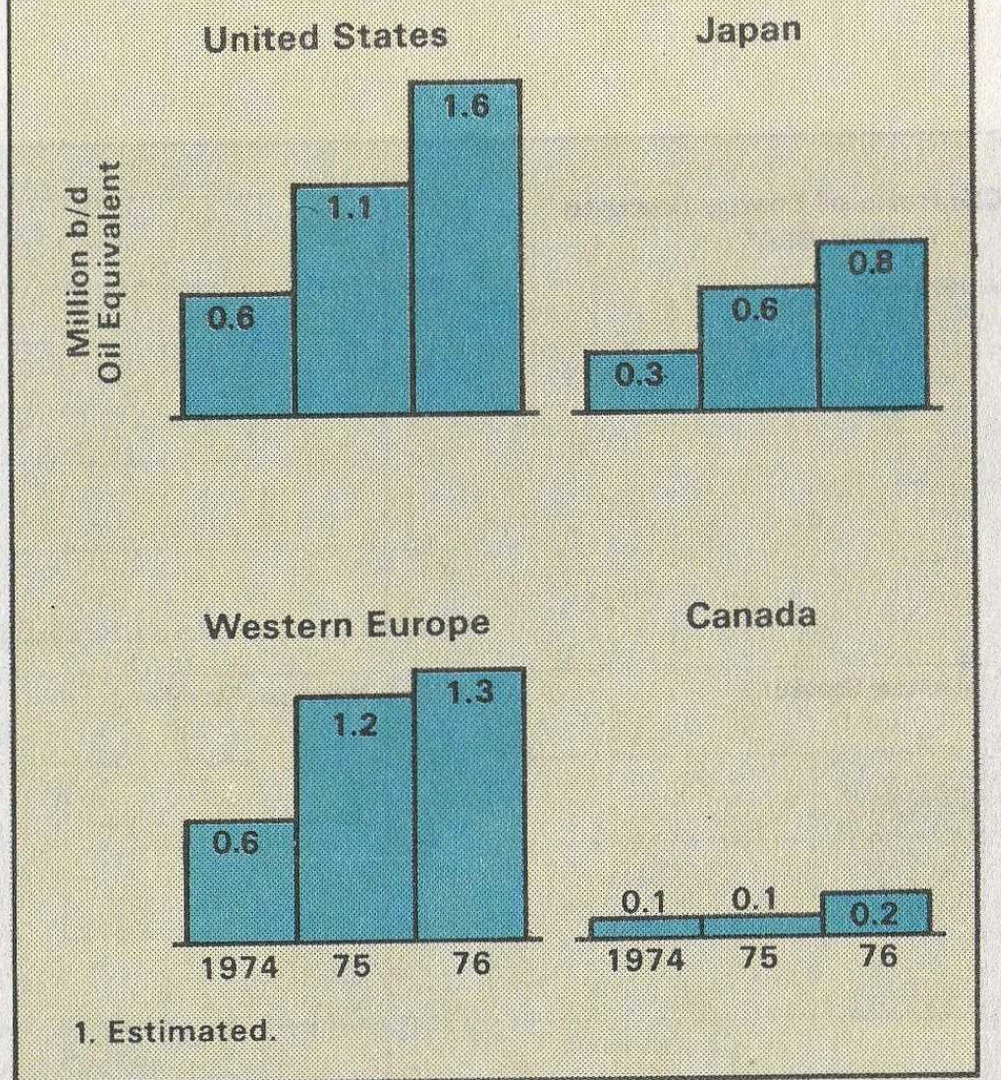
Figure 5

OECD: Energy Savings[1] Induced by 1974–76 OPEC Price Rise



1. Estimated.

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Confidential

Figure 6

OECD: Driving Age Population[1]

Percent Change

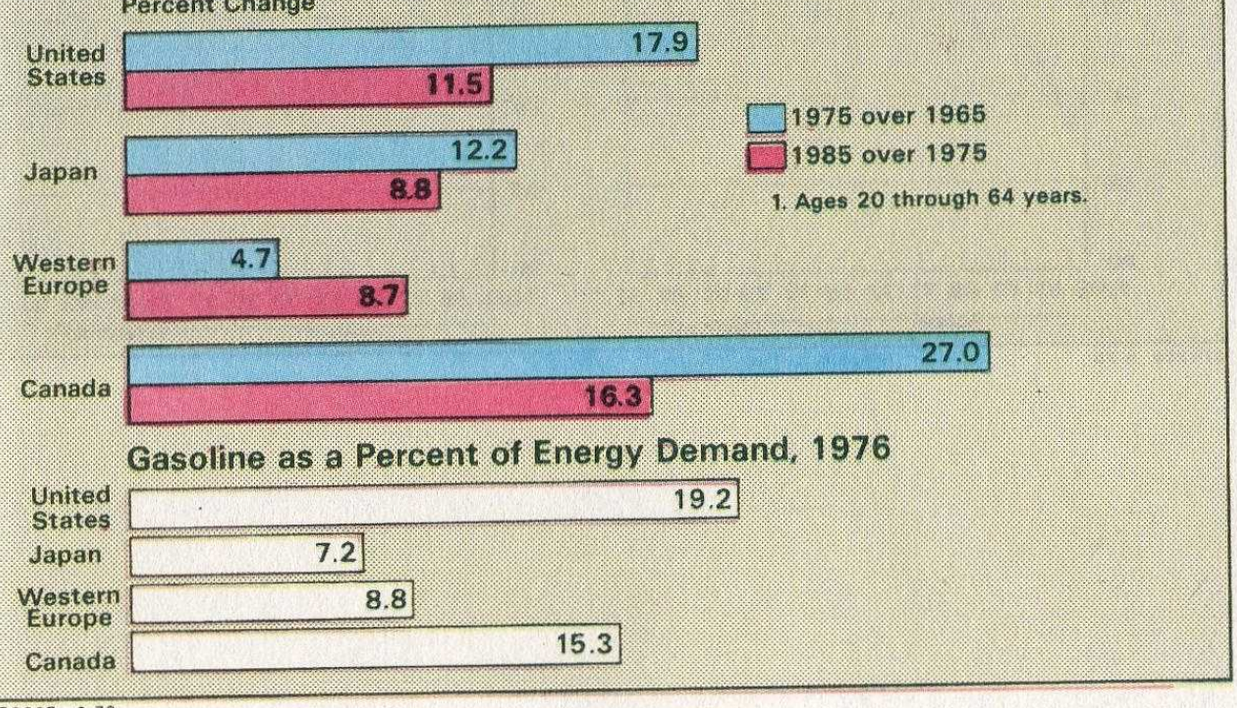

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Figure 7

OECD: Ratio of Energy Demand to Real GNP

Index: 1970=100

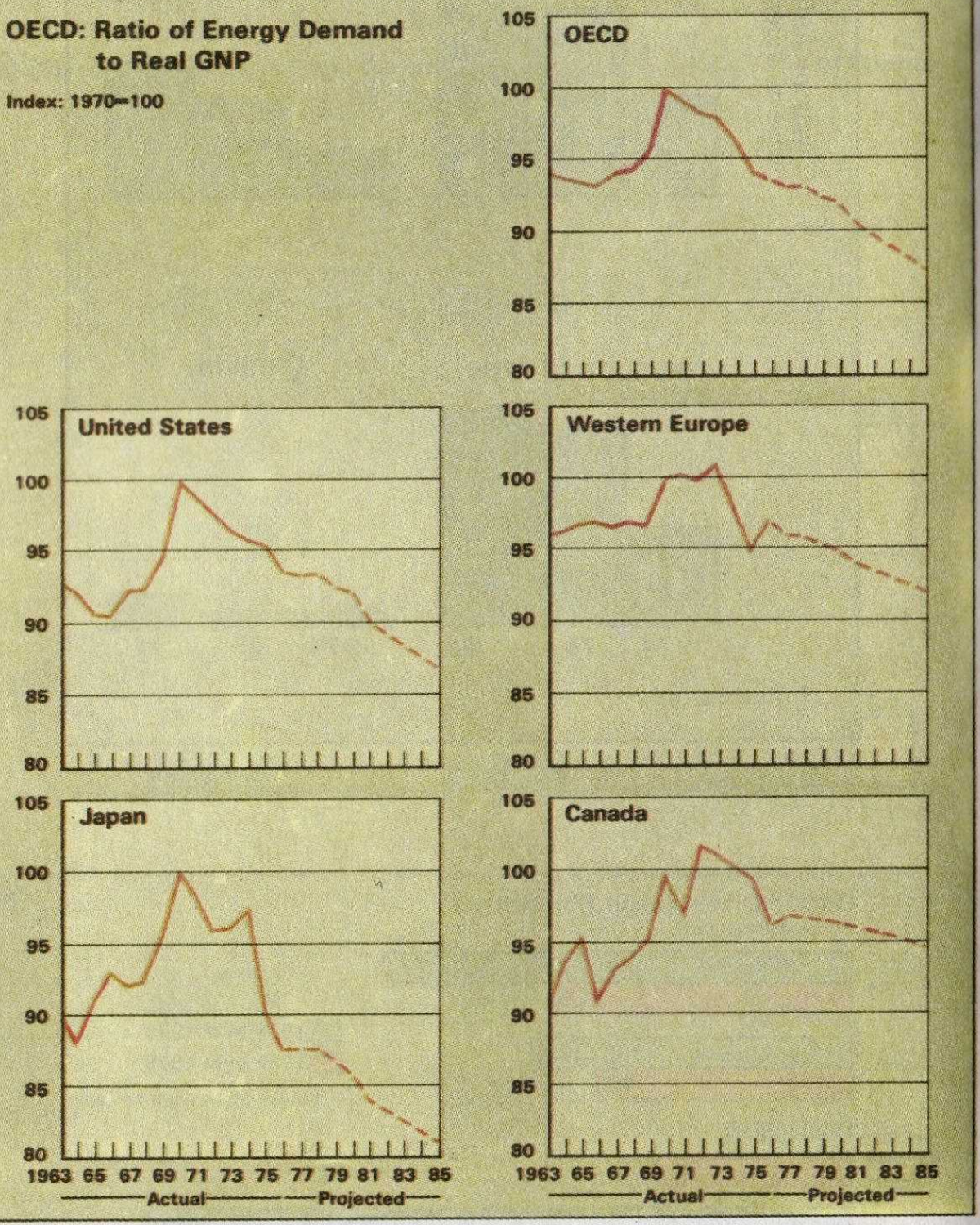

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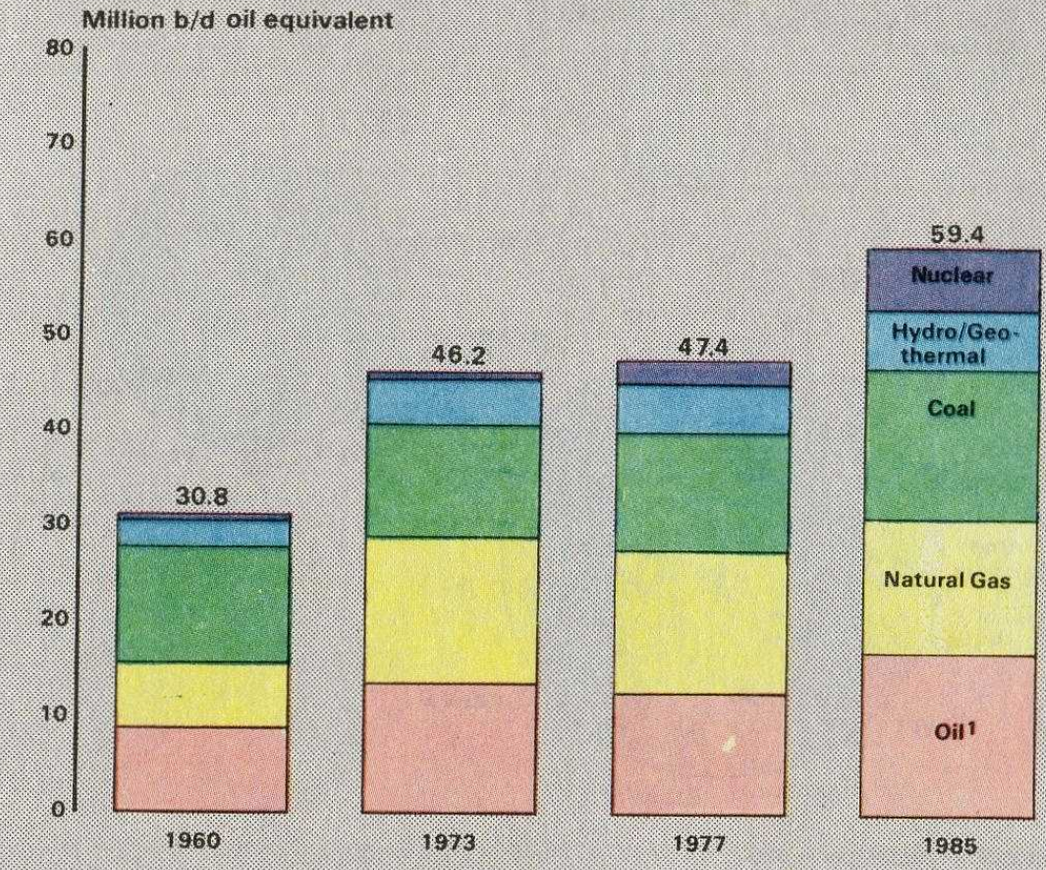
Figure 8

OECD: Energy Production by Type



1. Including natural gas liquids.

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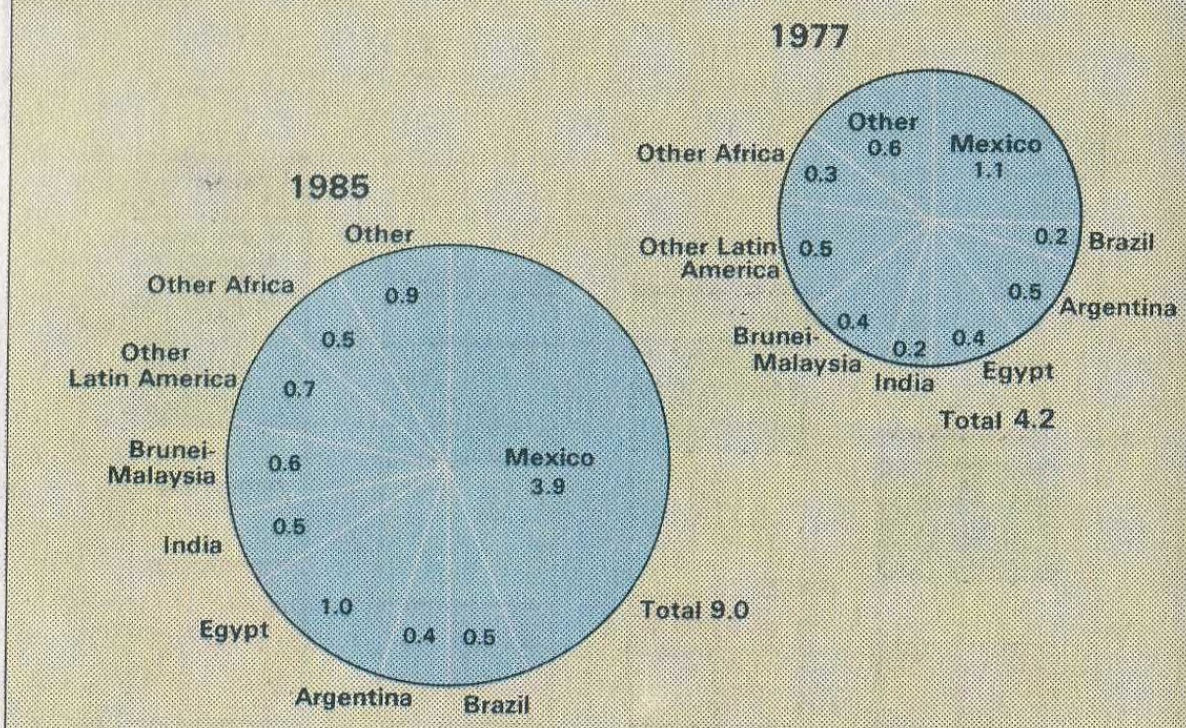
Figure 9

Non-OPEC LDCs: Oil Production[1]

Million b/d



1. Including natural gas liquids.

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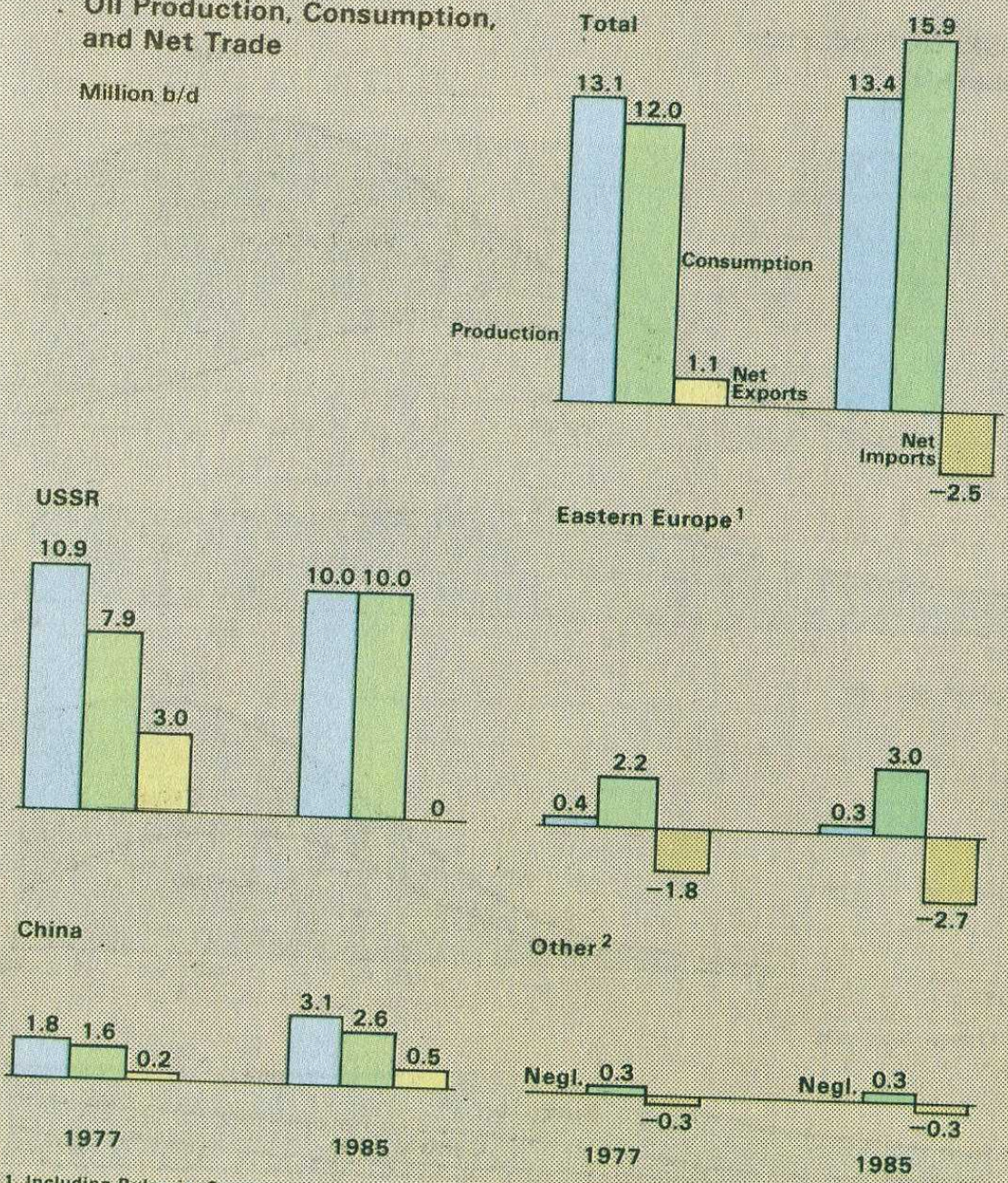
Secret

Figure 10

Communist Countries: Oil Production, Consumption, and Net Trade

Million b/d



1. Including Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, Romania, and Yugoslavia.
2. Including Albania, Cuba, Cambodia, Laos, Mongolia, North Korea, and Vietnam.

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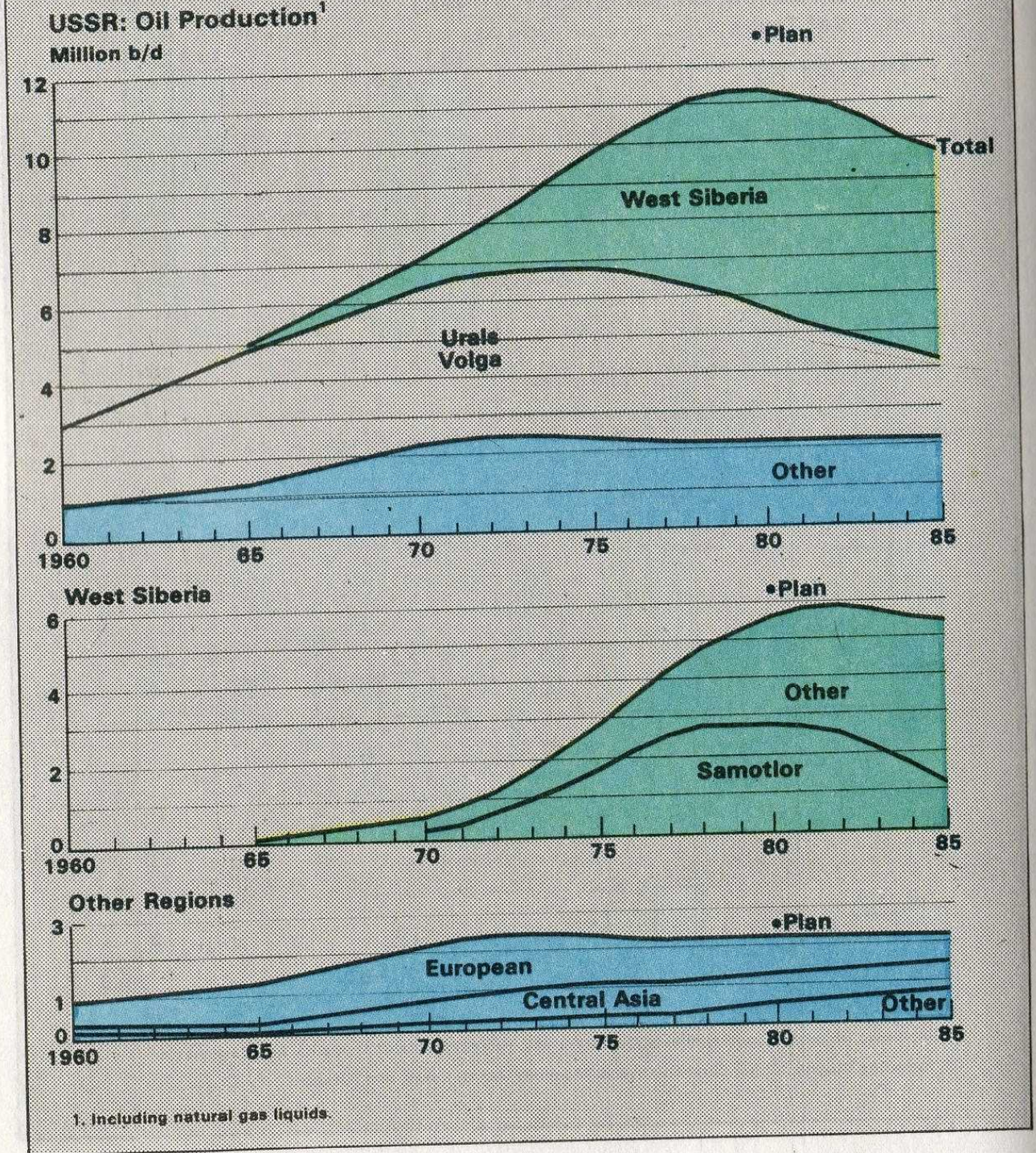
Figure 11



1. Including natural gas liquids.

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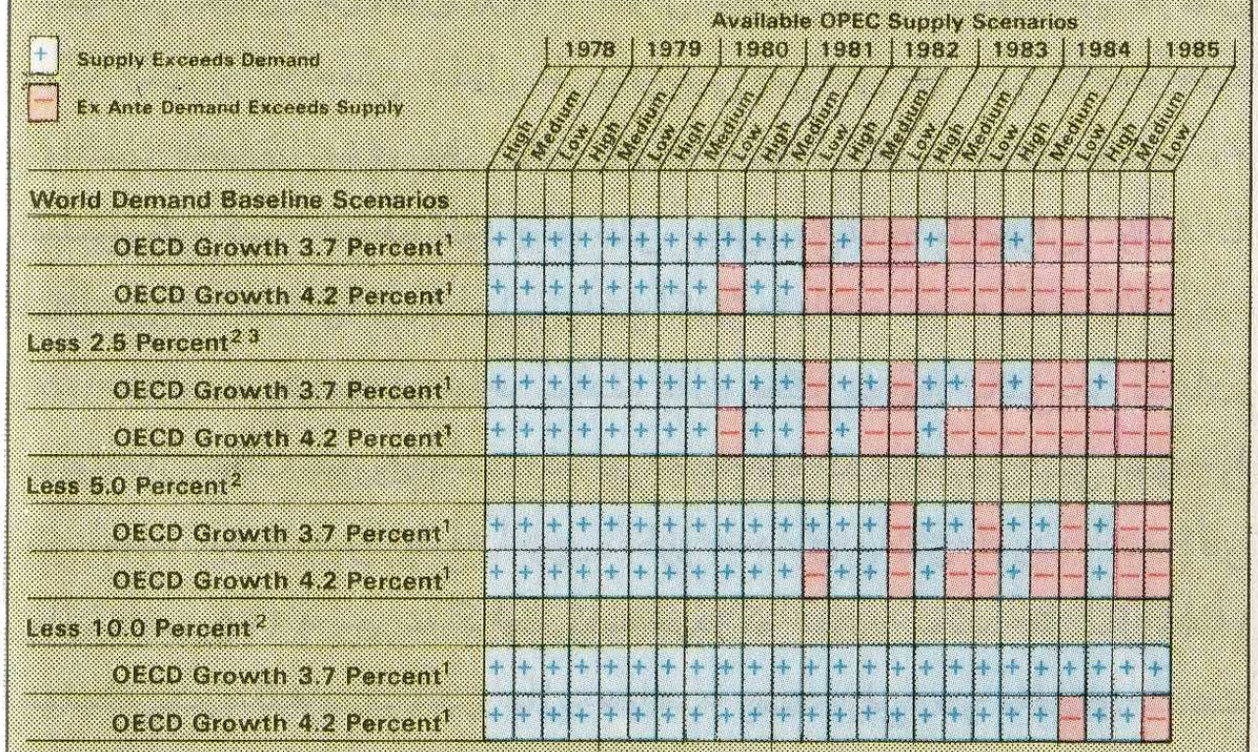
Figure 12

Supply of and Demand for OPEC Oil



1. Real GNP growth rates calculated from demographic trends, projections of labor force participation rates, and historical GNP/employment relationships. They imply constant OECD unemployment assuming the historical relationship between employment and GNP growth (OECD average 4.2 percent) or, alternatively, constant unemployment assuming a decline in the historic relationship of productivity to GNP growth (OECD average 3.7 percent).
2. From OECD energy demand in 1985, amounts rising linearly to these percentages in 1985.
3. This would be the approximate effect of energy legislation now pending in Congress, according to Department of Energy estimates.